

For Release

**Drucella Andersen**  
Headquarters, Washington, D.C.  
(Phone: 202/453-8613)

**April 1, 1992**

**Don Nolan**  
Ames-Dryden Flight Research Facility, Edwards, Calif.  
(Phone: 805/258-3447)

RELEASE: 92-44

## **NASA SLATES SUPERSONIC PERFORMANCE AND CONTROL TESTS**

NASA will soon start supersonic flight tests of a new electronic control system that will improve the performance, reliability and safety of high-speed military aircraft, future commercial supersonic transports and the X-30 National Aero-Space Plane.

A NASA F-15 research aircraft will begin supersonic testing of the Performance Seeking Control in April 1992 at NASA's Ames-Dryden Flight Research Facility, Edwards, Calif. The system monitors the plane's various computerized control systems in flight and automatically adjusts the combination of factors such as fuel flow and air flow into the engines to get the most thrust for the lowest possible revolutions per minute.

Researchers expect Performance Seeking Control to produce about 9 percent greater thrust and 10 percent less fuel consumption in the F-15 when it cruises above the speed of sound. Subsonic research flights with the system in 1990 boosted the F-15's engine power by 15 percent, lowered fuel usage by 2 percent and reduced engine temperature by 160 degrees F.

The improvements resulting from Performance Seeking Control have several benefits. Lower engine temperature prolongs engine life; in the F-15, for example, every drop of 70 degrees F reduces the rate of engine wear by 50 percent. The higher thrust shortens takeoff distance and lets fighter aircraft intercept a potential adversary more quickly.

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The technology also could expand to become an indicator of wear on engine parts by measuring stress in the engine turbine area. With normal preventive maintenance, the information could help insure fail-safe engine operation in high-speed aircraft.

Performance Seeking Control applies to many aircraft, but future supersonic airliners would benefit most because the system would throttle back the engines to their lowest possible operating rates while the plane flies at sustained supersonic speeds. The system also could be applied to the X-30 National Aero-Space Plane to integrate the X-30's various control systems.

McDonnell Aircraft Co., St. Louis, Mo., and United Technologies Pratt & Whitney Division, West Palm Beach, Fla., will participate in the research program with Ames-Dryden.

- end -

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400

Drucella Andersen  
Headquarters, Washington, D.C.  
(Phone: 202/453-8613)

For Release

April 2, 1992

Mary Ann Peto  
Lewis Research Center, Cleveland  
(Phone: 216/433-2902)

RELEASE: C92-3

## **COLEJON CORP. SELECTED BY NASA FOR CONTRACT NEGOTIATIONS**

NASA has selected the ColeJon Corp., Cleveland, for negotiations leading to award of a support service contract for operations, maintenance and repair of facilities at NASA's Lewis Research Center, Cleveland. Estimated value of the contract is approximately \$30 million.

A follow-on to the current contract that expires April 15, 1992, the new cost-plus-award-fee contract will be a basic 1-year contract with four 1-year option periods, for a total contract life of 60 months.

The contractor will be required to perform a variety of duties and tasks such as general building maintenance, including general carpentry, repairs to walls, ceilings and partitions, maintaining utility piping systems, sewage and waste systems and water treatment systems. The contractor also will be responsible for electrical motor repair and maintenance and repair of cabling and internal communications systems.

-end-

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400

Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

For Release

April 2, 1992

Release: 92-45

## **NASA SELECTS PARTICIPATING SCIENTISTS FOR MARS OBSERVER MISSION**

NASA has announced the selection of 33 participating scientists to take part in a wide range of investigations on the Mars Observer mission, planned for launch Sept. 16, 1992. These scientists will be added to the current science teams in October 1992 to increase the range of studies planned for the 2-year global mapping mission. Team leaders and interdisciplinary scientists were selected for Mars Observer in 1986.

"We are very glad to be able to provide this new scientific talent to the Mars Observer mission," said Dr. Wesley T. Huntress, Jr., Director of NASA's Solar System Exploration Division. "Mars Observer is the most complex mission we have ever flown to Mars, and it has a huge task to raise our understanding of Mars to a new level by obtaining long-term orbital data about the whole planet."

Mars Observer, America's first mission to Mars in more than 15 years, will be launched from the Kennedy Space Center, Fla., by a Titan-III expendable launch vehicle built by Martin Marietta Corp. The spacecraft itself will ride on the new Transfer Orbit Stage built by Orbital Sciences Corp., which will send the spacecraft out of Earth orbit on its way to Mars.

In August 1993, after an 11-month interplanetary cruise, the spacecraft will reach Mars where it will fire its on-board engines and enter a nearly polar orbit at an altitude of 240 miles. The spacecraft's seven instruments will record the global characteristics of Mars for slightly more than a full martian year (687 Earth days) to watch a full cycle of changes in the martian seasons. By early 1996, the spacecraft will have returned to Earth more than 600 billion bits of scientific data, more than has been collected by the nearly two dozen previous missions flown to Mars by the U.S. and the former U.S.S.R.

Besides representing U.S. universities and research centers, the newly-selected group of participating scientists include 4 individuals from the United Kingdom, France and Germany. Six scientists from Austria, the United Kingdom, France and Germany are already involved in the mission and a group of 10 participating scientists from Russia will be added later this year.

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Some of the 33 participating scientists will work with one of the seven instrument-related science teams. The instruments carried by Mars Observer are a gamma-ray detector to measure the chemical composition of the surface; a laser altimeter to measure the shape and topography of the surface; an infrared detector to measure surface mineral composition; a different infrared detector to measure the composition and behavior of the martian atmosphere; a magnetometer to measure the planet's magnetic field; and a camera to photograph the landscape at resolutions ranging from a few kilometers to several meters. In addition, careful tracking of the spacecraft's radio signal will make it possible to map the gravity field of Mars and some features of its atmospheric structure.

Other participating scientists will work with one of six interdisciplinary science teams, which will combine data collected by several different instruments to probe general questions of Mars' geology, atmospheric behavior, surface weathering, the influence of the polar caps and the migration of water and carbon dioxide between the atmosphere, the polar caps and the martian surface layer.

The wide range of Mars Observer science investigations will focus on solving several mysteries which were revealed but not settled by earlier U.S. missions to Mars, such as whether or not Mars has a magnetic field, where the water has gone and determining the mineral and chemical composition of martian soil and bedrock. The information gathered on the planet's gravitational field, atmospheric structure and surface topography and properties will be crucial to future human exploration of Mars.

"Mars Observer's mission is to make the first-ever global scientific inventory of an entire planet," said Dr. Bevan M. French, NASA's Program Scientist for the mission. "Mars is a complex world. Parts of it are like the Moon, with ancient rocks that preserve a record of intense meteorite bombardment during the early years of the solar system. Other parts of Mars are younger and more dynamic, like the Earth. These places have volcanoes, great fractures in the crust and large channels cut by running water a billion or two years ago."

"Mars also has polar ice caps, an atmosphere, clouds, frost, wind and sand dunes," he continued. "We want to understand how Mars formed and changed over time, why parts of it are similar to Earth and why other parts are utterly different."

Mars Observer also will support data collection by the Russian Mars-94 mission, which is planned to arrive at Mars in late 1995 and land small stations on the planet's surface. A communications relay on the Mars Observer spacecraft will relay data from the surface stations to Earth. Depending on the lifetime of the spacecraft, the same relay might be available later to send back data collected from Mars-96, a subsequent Russian mission that also will launch balloons into the martian atmosphere.

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Some of the Mars Observer's participating scientist investigations will look beyond Mars and even beyond the solar system. These include studies to detect and make high-resolution measurements of the mysterious gamma-ray "burster" events, studies of gamma-rays produced by violent high-energy flares on the Sun, and the first deep-space search for gravity waves using the extraordinarily precise tracking data from the Mars Observer communication system. Gravity waves are a fundamental phenomenon predicted by Einstein's Theory of Relativity but have yet to be detected.

NASA's Jet Propulsion Laboratory, Pasadena, Calif., manages the Mars Observer project for the Office of Space Science and Applications at NASA Headquarters, Washington, D.C.

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EDITOR'S NOTE: A list of the newly-selected participating scientists assigned to the seven instrument-related science teams and to the six interdisciplinary science teams is available by calling 202/453-8400.

**MARS OBSERVER PARTICIPATING SCIENTISTS**  
(Listed by Team Membership)

(NOTE: Only Participating Scientists were selected at this time. Team Leaders and Interdisciplinary Scientists were selected for Mars Observer in 1986.)

**1. INSTRUMENT-RELATED TEAMS**

**TEAM:   Gamma-Ray Spectrometer (GRS)**

BRUCKNER, Johannes (Max Planck Institute, GERMANY)  
"Experimental and theoretical simulations of the gamma-ray emission of Mars: implications for the chemical analysis of its surface"

DRAKE, Darrell M. (Los Alamos National Laboratory)  
"Study of martian volatiles via coupled neutron-gamma-ray fluxes"

EVANS, Larry G. (Computer Science Corporation)  
"Elemental composition and background determination for the Mars Observer Gamma-Ray Spectrometer"

LAROS, John G. (Los Alamos National Laboratory)  
"Gamma-ray burst studies using GRS"

STARR, Richard D. (Catholic University)  
"Analysis of X-ray and gamma-ray emissions from solar flares detected by the gamma-ray spectrometer"

**TEAM:   Magnetometer/Electron Reflectometer (MAG/ER)**

MENVIELLE, M. (University of Paris, FRANCE)  
"Study of the magnetic field of Mars with surface and satellite data"

MOHLMANN, Diedrich (German Aerospace Research Establishment (DLR), GERMANY)  
"Simultaneous and correlated magnetic measurements (SCMM)"

SLAVIN, James A. (NASA Goddard Space Flight Center)  
"An investigation of the Mars solar wind interaction and intrinsic magnetic field"

- more -

**TEAM: Mars Observer (Science) Camera (MOC)**

**DAVIES, Merton E. (RAND Corporation)**  
"The planetwide geodetic control network of Mars"

**HARTMANN, William K. (Planetary Science Institute)**  
"Nature and duration of martian climate changes, studied through  
martian craters and other geomorphic indicators"

**JAMES, Philip B. (University of Toledo)**  
"Behavior of clouds and polar condensates on Mars"

**McEWEN, Alfred S. (U.S. Geological Survey)**  
"Martian color and albedo variations"

**THOMAS, Peter C. (RAND Corporation)**  
"Eolian sediments, seasonal changes, and topography of Mars  
studied with the Mars Observer Camera"

**TEAM: Mars Observer Laser Altimeter (MOLA)**

**BANERDT, W. Bruce (Jet Propulsion Laboratory)**  
"MOLA Participating Scientist: geophysical modelling of Mars"

**DUXBURY, Thomas C. (Jet Propulsion Laboratory)**  
"MOC Geosciences: geodesy, cartography, and topography"

**TEAM: Pressure Modulator Infrared Radiometer (PMIRR)**

**ALLISON, Michael D. (Goddard Institute for Space Sciences)**  
"Martian general circulation statistics via the objective analysis  
of PMIRR data"

**BARNES, Jeffrey R. (Oregon State University)**  
"Extratropical eddies in the atmospheric circulation and climate  
system of Mars"

**MARTIN, Terry Z. (Jet Propulsion Laboratory)**  
"Atmospheric studies with the Mars Horizon Sensor Assembly"

**READ, Peter L. (University of Oxford, ENGLAND)**  
"Baroclinic wave dynamics and orographic influences in the  
martian atmosphere: model/data comparisons using PMIRR"

**TEAM: Thermal Emission Spectrometer (TES)**

**CLANCY, R. Todd (University of Colorado)**

**"Visible dust and cloud opacities from Mars Observer"**

**CONRATH, Barney J. (NASA Goddard Space Flight Center)**

**"Investigation of the structure and dynamics of the martian atmosphere using thermal emission spectra"**

**ROUSCH, Ted L. (San Francisco State University)**

**"Collection, reduction, and interpretation of thermal emission spectrometer data and their relationship to volatile-bearing minerals on Mars"**

**TEAM: Radio Science (RS)**

**ARMSTRONG, John W. (Jet Propulsion Laboratory)**

**"A search for low-frequency gravitational radiation using the Mars Observer telecommunications system"**

**FLASAR, F. Michael (NASA Goddard Space Flight Center)**

**"Meteorological studies of Mars from Radio Science observations"**

**SIMPSON, Richard A. (Stanford University)**

**"Bistatic radar studies of Mars surface"**

**2. INTERDISCIPLINARY SCIENCE TEAMS:**

**TEAM: Interdisciplinary Scientist (Atmospheres/Climatology)**

**HABERLE, Robert M. (NASA Ames Research Center)**

**"The role of atmospheric transport in the current seasonal water cycle on Mars"**

**TEAM: Interdisciplinary Scientist (Data Management/Surface Weathering)**

**FEGLEY, Bruce (Washington University, St. Louis)**

**"Constraints on martian chemical weathering from Mars Observer Data"**

**TEAM: Interdisciplinary Scientist (Geosciences)**

**GOLUMBEK, Matthew (Jet Propulsion Laboratory)**  
"Structural geology of Mars"

**McSWEEN, Harry Y. (University of Tennessee)**  
"Petrologic map of bedrock for Mars Observer"

**TEAM: Interdisciplinary Scientist (Polar Atmospheric Sciences)**

**HOUBEN, Howard (Space Physics Research Institute)**  
"Meteorological analyses and short-term forecasting with Mars Observer data"

**TEAM: Interdisciplinary Scientist (Surface-Atmosphere Interactions)**

**ZENT, Aaron P. (SETI Institute)**  
"Mars Observer surface-atmosphere interaction IDS Support"

**TEAM: Interdisciplinary Scientist (Surface Properties and Morphology)**

**HERKENHOFF, Ken (Jet Propulsion Laboratory)**  
"Topography and composition of the polar layered deposits on Mars"

**MURRAY, Bruce C. (California Institute of Technology)**  
"Mars Observer participating scientist program"

Paula Cleggett-Haleim  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

For Release  
April 6, 1992

Randee Exler  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-7277)

NOTE TO EDITORS: N92-28

## **HUBBLE AND COMPTON DISCOVERIES BRIEFING SET FOR APRIL 8**

The most exotic and powerful objects in the universe will be the subject of a media briefing on Wednesday, April 8, 1992, at 1:00 p.m. EDT in the NASA auditorium, 400 Maryland Ave., S.W.

New information about a potential, massive black hole in our galactic backyard only 2.3 million light years away, will be presented by Dr. Tod Lauer, a Hubble Space Telescope scientist. The result is based on analysis by Dr. Lauer of the National Optical Astronomy Observatories, Tucson, Ariz., and the Wide Field/Planetary Camera imaging team.

The discovery of a new class of "gamma ray quasars," which may emit huge energies in directed beams, will be announced by Dr. Neil Gehrels, Project Scientist for the Compton Gamma Ray Observatory, at NASA's Goddard Space Flight Center, Greenbelt, Md.

The significance of the new findings and their context in the unfolding knowledge of the universe will be discussed by a panel of distinguished astronomers, including Dr. Bruce Margon, Professor of Astronomy and Chairman of the Department of Astronomy, University of Washington, Seattle; Dr. Daniel Weedman, Professor of Astronomy at Pennsylvania State University, University Park; and Dr. Steve Maran, Senior Staff Scientist at NASA's Goddard Space Flight Center.

This event will be carried on NASA Select Television (Satcom F-2R, Transponder 13, 72 degrees west longitude, frequency 3960.0 MHz, audio 6.8 MHz). Questions will be taken from reporters at Headquarters and at NASA centers.

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An image and a 4-minute video to accompany this briefing are available to news media by calling NASA's Broadcast and Audio Visual Branch on 202/453-8594. The image, available in color and black and white, depicts the compact core of galaxy M32 and the video depicts an imaginary view from the core of galaxy M32 and a collapsing core of galaxy M32.

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Color: 92-HC-191

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# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
AC 202 453-8400



For Release  
April 8, 1992  
7:30 p.m. EDT

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/453-8536)

James Hartsfield  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

Lisa Malone  
Kennedy Space Center, Fla.  
(Phone: 407/867-2468)

June Malone  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205/544-0034)

## STS-49 ENDEAVOUR LAUNCH PROCESSING STATUS

Following a final review of information from Endeavour's flight readiness firing, two irregularities were identified in two engines and Shuttle managers have decided to remove and replace Endeavour's three main engines prior to STS-49.

Replacing the main engines adds, at most, one or two days of work to the launch preparations already under way, and launch of STS-49 in the first week of May is still anticipated. An official launch date will be announced by managers following the STS-49 flight readiness review now scheduled for April 21.

The irregularities would not have been a safety concern had Endeavour's engine test been an actual launch, and it is believed all three engines would have performed well under such circumstances. The decision to replace the engines is dictated by prudence and the fact that the work will have little impact on the launch preparation schedule.

The irregular items included a build up of pressure in the liquid oxygen preburner seen just after shut off of engine number one. Such pressure build-ups have been seen before and usually occur only after an engine shut down at sea-level altitude. However, the build up requires that the engine's oxidizer preburner face plate be inspected for any deflections it may have caused.

On engine number two, a slightly elevated frequency in the vibrations of ball bearings in the high pressure oxidizer turbopump indicated the possible beginnings of wear in the bearings. However, the indications of wear are not sufficiently great to cause a concern that the engine would not have operated well for the eight and half minutes required during launch.

# # #

Paula Cleggett-Haleim  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

For Release  
April 8, 1992

Ray Villard  
Space Telescope Science Institute, Baltimore, Md.  
(Phone: 410/338-4514)

Dr. Tod Lauer  
National Optical Astronomy Observatories, Tuscon, Ariz.  
(Phone: 602/325-9290)

Dr. Sandra Faber  
University of California, Santa Cruz  
(Phone: 408/459-2944)

RELEASE: 92-46

## **NASA'S HUBBLE FINDS NEW EVIDENCE FOR MASSIVE BLACK HOLES**

Astronomers report that they have found new evidence that a black hole, weighing 3 million times the mass of the Sun, exists at the center of the nearby elliptical galaxy M32, based on images obtained with NASA's Hubble Space Telescope (HST). The images show that the stars in M32 become extremely concentrated toward the nucleus.

This central structure resembles the gravitational "signature" of a massive black hole. The presence of a black hole in an ordinary galaxy like M32 may mean that inactive black holes are common to the centers of galaxies. The new HST images show that M32 is an interesting "laboratory" for testing theories of the formation of massive black holes.

This result is based on image analysis conducted by Dr. Tod R. Lauer of the National Optical Astronomy Observatories, Tuscon, Ariz., Dr. Sandra M. Faber of the University of California, Santa Cruz, and other members of the HST Wide Field/Planetary Camera (WFPC) Imaging Team.

M32 is quite small and compact as elliptical galaxies go, containing about 400 million stars within a diameter of only 1,000 light-years. At a distance of 2.3 million light-years, M32 (the 32nd object in a catalog of non-stellar objects compiled by French astronomer Charles Messier in 1774) is one of the closest neighbors to the Milky Way galaxy.

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M32 is a satellite of the great spiral galaxy in Andromeda M31, which dominates the small group of galaxies of which the Milky Way is a member. M31 can be seen with the naked eye as a spindle-shaped "cloud" the width of the full moon, and its small companion M32 can be seen with a small telescope.

M32 has been among the best candidates for a galaxy with a massive central black hole. This was first proposed in 1987 by Dr. John L. Tonry of the Massachusetts Institute of Technology, Cambridge, and independently by Dr. Alan Dressler of the Observatories of the Carnegie Institution, Wash., and by Dr. Douglas O. Richstone of the University of Michigan, Ann Arbor.

Their observations, made with ground-based telescopes, showed an abrupt increase in the orbital velocities of stars towards the center of M32. This data led the astronomers to conclude that M32 must have a strong but unseen concentration of mass at its center. A black hole at least several million times the mass of the Sun is the most likely type of object matching these characteristics.

Ground-based images, however, do not have enough resolution to detect the effects of a massive black hole on the structure of M32. The HST images analyzed by Lauer, Faber and co-investigators on the WFPC imaging team now show the nucleus of M32 in clear detail.

They find that the density of stars in the nucleus of M32 appears to increase steadily towards the center, with no sign of leveling off. These results are very similar to the predictions for what a massive black hole should do to the central structure of a galaxy.

"This is the densest stellar system known to astronomers," says Lauer. "The density of stars at the center of M32 may be over 100 million times greater than the distribution of stars in the neighborhood of the Sun. A visitor to a planet at the center of M32 would see a starry night sky so saturated with stars that their combined light would be brighter than 100 full moons. The night would never get darker than mid-twilight on the Earth, and one could even read a newspaper by starlight."

To date, HST has uncovered the gravitational signature of a black hole in one other galaxy, the giant elliptical galaxy called M87. Both M32 and M87 have a distinctive central concentration of starlight called a "cusp." These two galaxies are quite different, though, in that the black hole proposed for M32 is roughly 1,000 times smaller than the black hole that might exist at the heart of M87.

Although M32 is about 20 times closer to the Earth than M87, its much smaller black hole means that the brightness cusp also is much smaller and is close to HST's resolution limits. Unlike M87, M32 lacks any form of nuclear activity, which means that at present the black hole would not be accreting significant amounts of matter. This result also raises the possibility that small inactive black holes are common to the centers of galaxies.

Because the region dominated by the black hole is so small, Lauer and Faber also considered the possibility that no black hole is present. Instead, the star density might level off just beyond the resolution limits of HST. If this were the case for M32, it would force the researchers to conclude that the center of M32 is unstable and vulnerable to collapse.

A black hole at the center of M32 would have the paradoxical effect of stabilizing the galaxy's nucleus. That's because the stars orbit so rapidly around the black hole, they move past each other too quickly to gravitationally capture each other or collide. The black hole thus keeps the center of a galaxy "stirred up."

In the absence of a black hole, however, the stars would move slowly enough to attract each other gravitationally. Collisions between stars become much more frequent, and heavier slower moving stars sink to the center of the galaxy causing it to collapse.

The fate of the collapsing core is uncertain. One possibility is that binary stars formed during the collapse would provide enough kinetic energy to halt the collapse by transferring momentum to single stars. This would make the core rebound, like a rubber ball that has been squeezed and then relaxed.

An alternative possibility is that runaway merging of stars would occur during core collapse, leading to the formation of a black hole in any case. If so, this would rule out alternative explanations that don't require a black hole.

If the core is really unstable, the researchers would expect to find evidence of merged and captured stars called "blue stragglers" (HST has in fact uncovered such stars at the core of a globular cluster, a much smaller aggregate of stars than M32). The shape of the starlight distribution at the core would also be different from that which HST detects.

The Hubble images instead show that the population of stars in the nucleus is the same as that further out in the galaxy, and that the shape of M32 remains constant into the center. This means that a core collapse has not recently occurred.

At the present time, astrophysical theories are not sophisticated enough to say whether or not M32 would have to evolve to make a central black hole, but do raise this as an intriguing possibility. The new HST observations thus identify M32 as an interesting "laboratory" where astronomers can test theories of massive black hole formation.

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The search for super massive black holes in the cores of galaxies is one of the primary missions of NASA's Hubble Space Telescope. By investigating both active and quiescent galaxies, astronomers will have a better idea of the conditions and events which lead to the formation and growth of super-massive black holes.

The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, Inc., for NASA, under contract with the Goddard Space Flight Center, Greenbelt, Md. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency.

- end -

For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/453-1549 )

April 8, 1992

Randee Exler  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-8955 )

RELEASE: 92-47

## COMPTON OBSERVATORY DETECTS ACTIVE GALAXIES

NASA's Compton Gamma Ray Observatory has made the first detection of high-energy gamma rays from a class of active galaxies similar to quasars. The observations, made by the Energetic Gamma Ray Experiment Telescope (EGRET), suggest that high-energy gamma radiation provides a substantial contribution to the objects' overall luminosity.

These active galaxies are called BL Lacertae objects, a type of "quasar-like" object that emits vast but varying amounts of energy. The candidate objects are in the constellations Ursa Major, Pictor and Camelopardalis. They are designated as MK 421, 0537-441 and 0716+714, respectively.

These new gamma-ray results support the hypothesis that BL Lacertae objects, like quasars, may be powered by supermassive black holes. The detection of these high energy gamma rays also provides another piece of evidence suggesting their similarity to quasars and adds important new insight into understanding the nature of BL Lacertae objects.

The EGRET science team previously reported detection of high energy gamma rays from six quasars. The most intense, called 3C 279, registered a total high-energy gamma ray emission more than 10- to 100-million times that of the Milky Way galaxy.

EGRET, one of four instruments aboard the Compton Observatory, was assembled in-house by the Goddard Space Flight Center, Greenbelt, Md. The U.S. Principal Investigator for EGRET is Dr. Carl Fichtel of NASA's Goddard Space Flight Center.

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Co-principal investigators for EGRET are Dr. Carl Fichtel, of Goddard, and Dr. Klaus Pinkau, Max Planck Institute for Extraterrestrial Physics, Garching, Germany. EGRET is the joint effort by scientists and engineers at Goddard; Stanford University, Calif.; Max Planck Institute and Grumman Aerospace Corp., Bethpage, N.Y.

The second of NASA's Great Observatories, the Compton Observatory was launched April 5, 1991, by the Space Shuttle Atlantis to study high-energy radiation from space. The Compton Observatory is managed and operated by Goddard for NASA's Office of Space Science and Applications, Washington, D.C.

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# Space Shuttle Mission STS-49 Press Kit

92-48

## Maiden Voyage of *Endeavour*



May 1992

**PUBLIC AFFAIRS CONTACTS**

Mark Hess/Jim Cast/Ed Campion  
Office of Space Flight/Office of Space Systems Development  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-8536)

Barbara Selby  
Office of Commercial Programs  
NASA Headquarters, Washington, D.C.  
(Phone: 703/557-5609)

Jean Drummond Clough  
Langley Research Center, Hampton, Va.  
(Phone: 804/864-6122)

Nancy Lovato  
Ames-Dryden Flight Research Facility, Edwards, Calif.  
(Phone: 805/258-3448)

Mike Simmons  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205/544-6537)

James Hartsfield  
Johnson Space Center, Houston, Tex.  
(Phone: 713/483-5111)

Lisa Malone  
Kennedy Space Center, Fla.  
(Phone: 407/867-2468)

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Release: 92-48

## **SATELLITE RESCUE, SPACEWALKS MARK ENDEAVOUR'S FIRST FLIGHT**

Endeavour's maiden space flight, STS-49, features rendezvous, repair and reboost of a crippled communications satellite. Also astronauts will perform spacewalks over three consecutive days, a first on a Space Shuttle mission, to demonstrate Space Station Freedom assembly techniques.

The launch of STS-49 is currently planned for 8:03 p.m. EDT May 5. Endeavour will be placed into an elliptical orbit of 183 by 95 n.m. with an inclination of 28.35 degrees to the equator. With an on-time launch, landing would be at 7:58 p.m. EDT May 12 at Edwards Air Force Base, Calif. Mission duration is 6 days, 23 hours and 55 minutes.

Endeavour's crew -- Commander Dan Brandenstein, Pilot Kevin Chilton and Mission Specialists Pierre Thuot, Rick Hieb, Kathy Thornton, Tom Akers and Bruce Melnick -- will rendezvous with the INTELSAT VI (F-3) communications satellite on the 4th day of the flight. The INTELSAT VI was launched 2 years ago by an unmanned Titan rocket and stranded in a useless, low orbit when the Titan's second stage failed to separate.

During the first spacewalk on flight day 4, Thuot will grasp the satellite using a specially designed capture mechanism. Thuot and Hieb will attach a new solid rocket motor and then deploy the satellite. INTELSAT VI's final destination will be a 22,300 n.m. high orbit where it will be stationary above the Atlantic Ocean, providing telecommunications services to more than 180 countries for at least the rest of this decade.

On flight days 5 and 6, a Thornton and Akers team and a Thuot and Hieb team will perform spacewalks to evaluate equipment and techniques for constructing Space Station Freedom. The evaluations will include construction of a pyramid simulating the space station truss structure; the ability of an astronaut to manipulate large, heavy objects in weightlessness; and the usefulness of five prototype devices to assist a spacewalker, whose tether has come loose, in getting back to his spacecraft.

In addition, Endeavour will carry the Commercial Protein Crystal Growth experiment in its middeck, an ongoing series of experiments that grow near-perfect protein crystals in weightlessness for use in developing new products and drugs. The Air Force Maui Optical Station, a facility located on the Hawaiian island of Maui, will attempt to calibrate its equipment by viewing jet firings and water dumps from Endeavour. An Ultraviolet Plume Instrument on the LACE satellite will observe the Shuttle for calibration information. Endeavour's first flight will be the 47th Space Shuttle mission.

- end of general release -

## **MEDIA SERVICES**

### **NASA Select Television Transmission**

NASA Select television is available on Satcom F-2R, Transponder 13, located at 72 degrees west longitude; frequency 3960.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for the mission briefings from the Johnson Space Center, Houston, will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Ames-Dryden Flight Research Facility, Edwards, Calif.; Johnson Space Center; and NASA Headquarters, Washington, D.C. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR, 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule may be obtained by dialing 202/755-1788. This service is updated daily at noon ET.

### **Status Reports**

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter.

### **Briefings**

A mission press briefing schedule will be issued prior to launch. During the mission, change-of-shift briefings by the off-going flight director will occur at least once per day. The updated NASA Select television schedule will indicate when mission briefings are planned.

**STS-49 QUICK LOOK FACTS**

Orbiter:	Endeavour (OV-105)
Launch Date/Time:	May 5, 1992 - 8:03 p.m. EDT
Launch Window:	53 minutes
Launch Site:	Kennedy Space Center, Fla., Pad 39-B
Altitude/Inclination:	183 x 95 n.m./28.35 degrees
Duration:	7 Days
Landing Date/Time:	May 12, 1992 - 7:58 p.m. EDT (6/23:55 MET)
Primary Landing Site:	Edwards Air Force Base, Calif.
Abort Landing Sites:	Return to Launch Site - Kennedy Space Center, Fla. Transoceanic Abort Landing - Ben Guerir, Morocco Abort Once Around - Edwards Air Force Base, Calif.
Crew:	Daniel C. Brandenstein - Commander Kevin P. Chilton - Pilot Bruce E. Melnick - Mission Specialist Pierre J. Thuot - Mission Specialist (EV1) Richard J. Hieb - Mission Specialist (EV2) Kathryn C. Thornton - Mission Specialist (EV3) Thomas D. Akers - Mission Specialist (EV4)
Cargo Bay:	Assembly of Station Methods (ASEM) INTELSAT-VI Repair & Reboost Equipment
Middeck:	Commercial Protein Crystal Growth (CPCG)

# <sup>6</sup> *Maiden Voyage of Endeavour*

## STS-49 Launch Period

Launch Date	Launch Period Opens			Launch Period Closes			Duration
	GMT	EDT	CDT	GMT	EDT	CDT	
05/05/92	00:03 (5/6)	8:03 p.m.	7:03 p.m.	00:56 (5/6)	8:56 p.m.	7:56 p.m.	53 minutes
05/06/92	23:37	7:37 p.m.	6:37 p.m.	00:25 (5/7)	8:25 p.m.	7:25 p.m.	48 minutes
05/07/92	23:06	7:06 p.m.	6:06 p.m.	23:55	7:55 p.m.	6:55 p.m.	49 minutes
05/08/92	22:36	6:36 p.m.	5:36 p.m.	23:29	7:29 p.m.	6:29 p.m.	53 minutes
05/09/92	22:06	6:06 p.m.	5:06 p.m.	22:58	6:58 p.m.	5:58 p.m.	52 minutes
05/10/92	21:39	5:39 p.m.	4:39 p.m.	22:27	6:27 p.m.	5:27 p.m.	48 minutes
05/11/92	21:08	5:08 p.m.	4:08 p.m.	22:00	6:00 p.m.	5:00 p.m.	52 minutes
05/12/92	20:37	4:37 p.m.	3:37 p.m.	21:30	5:30 p.m.	4:30 p.m.	53 minutes
05/13/92	20:13	4:13 p.m.	3:13 p.m.	21:00	5:00 p.m.	4:00 p.m.	47 minutes
05/14/92	19:40	3:40 p.m.	2:40 p.m.	20:29	4:29 p.m.	3:29 p.m.	49 minutes

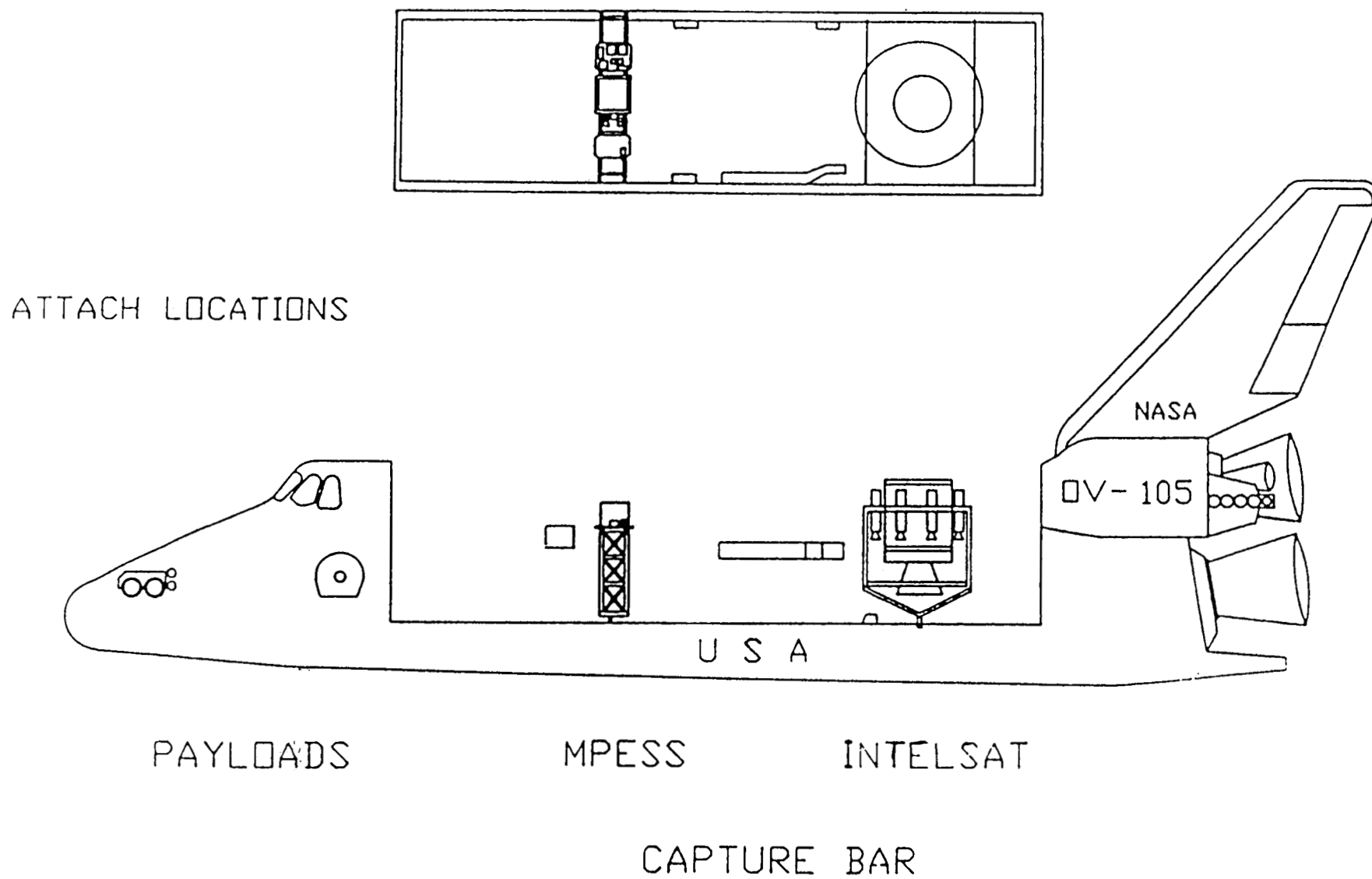
Note: Mission Duration is 06/23:55

**STS-49 SUMMARY OF MAJOR ACTIVITIES**  
(Calendar Days)

Day One:	Ascent; Orbital Maneuvering System-2; first orbit-raising burn
Day Two:	Cabin depressurization to 10.2 psi; spacesuit checkout; mechanical arm checkout; second orbit-raising burn
Day Three:	Detailed Test Objectives (DTOs) and Detail Supplementary Objectives (DSOs); orbit, circularization, plane correction burns
Day Four:	INTELSAT rendezvous; spacewalk to attach perigee kick motor; INTELSAT deploy
Day Five:	Assembly of Space Station by Extravehicular Activity Methods spacewalk
Day Six:	Assembly of Space Station by Extravehicular Activity Methods spacewalk
Day Seven:	Flight control systems checkout; reaction control system hot fire; DTOs, DSOs
Day Eight:	Deorbit; entry; landing

**STS-49 VEHICLE AND PAYLOAD WEIGHTS**

	Pounds
Orbiter (Endeavour) empty, and 3 Shuttle Main Engines	173,314
INTELSAT perigee kick motor	23,195
INTELSAT cradle, airborne support equipment	4,418
INTELSAT support equipment	76
Assembly of Space Station by EVA Methods (ASEM)	3,990
ASEM support equipment	273
Commercial Protein Crystal Growth	69
Detailed Supplementary Objectives	35
Detailed Test Objectives	171
Total Vehicle at Solid Rocket Booster Ignition	4,522,750
Orbiter Landing Weight	201,088



STS-49 CARGO BAY CONFIGURATION

**STS-49 TRAJECTORY SEQUENCE OF EVENTS**

<b>EVENT</b>	<b>MET (d:h:m:s)</b>	<b>RELATIVE VELOCITY (fps)</b>	<b>MACH</b>	<b>ALTITUDE (ft)</b>
Launch	00/00:00:00			
Begin Roll Maneuver	00/00:00:10	185	.16	782
End Roll Maneuver	00/00:00:15	319	.28	2,720
SSME Throttle to 89%	00/00:00:20	447	.40	3,980
SSME Throttle to 67%	00/00:00:32	742	.67	10,301
SSME Throttle to 104%	00/00:00:59	1,325	1.28	33,760
Maximum Dyn. Pressure (Max Q)	00/00:01:02	1,445	1.43	38,079
SRB Separation	00/00:02:05	4,151	3.81	154,985
Main Eng. Cutoff (MECO)	00/00:08:30	24,542	22.61	364,738
Zero Thrust	00/00:08:36	24,541	N/A	363,652
External Tank Separation	00/00:08:48			
OMS-2 Burn	00/00:39:58			
Landing	06/23:55:00			

Apogee, Perigee at MECO: 179 x 32 nautical miles  
 Apogee, Perigee post-OMS 2: 183 x 95 nautical miles

## SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, orbiter and its payload. Abort modes include:

\* **Abort-To-Orbit (ATO)** -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.

\* **Abort-Once-Around (AOA)** -- Earlier main engine shutdown with the capability to allow one orbit around before landing at either Edwards Air Force Base, Calif., White Sands Space Harbor, N.M, or the Shuttle Landing Facility (SLF) at the Kennedy Space Center, Fla.

\* **Trans-Atlantic Abort Landing (TAL)** -- Loss of one or more main engines midway through powered flight would force a landing at either Ben Guerir, Morocco; Moron, Spain; or Rota, Spain.

\* **Return-To-Launch-Site (RTL)** -- Early shutdown of one or more engines, and without enough energy to reach Ben Guerir, would result in a pitch around and thrust back toward KSC until within gliding distance of the SLF.

STS-42 contingency landing sites are Edwards Air Force Base, Kennedy Space Center, White Sands Space Harbor, Ben Guerir, Moron and Rota.

## **STS-49 PRE-LAUNCH PROCESSING**

Endeavour arrived at KSC on May 7, 1991, several days after it rolled off the assembly floor of Rockwell International in Palmdale, Calif. Many systems on board Endeavour feature design changes or updates as part of continued improvements to the Space Shuttle. The upgrades include several improved or redesigned avionics systems, the drag chute and modifications to pave the way for possibly extending shuttle flights to last as long as 16 days.

Endeavour underwent rigorous first flight processing required of new orbiters during its stay in the Orbiter Processing Facility (OPF). The Shuttle team installed major components associated with a new vehicle and performed general processing operations.

Endeavour was transferred out of the OPF on March 7, just 10 months after its arrival at Kennedy Space Center. Endeavour was towed several hundred yards to the Vehicle Assembly Building and connected to its external tank and solid rocket boosters on the same day.

The new orbiter spent 6 days in the VAB while technicians connected the 100-ton space plane to its already stacked solid rocket boosters and external tank. Endeavour was transferred to newly refurbished launch pad 39-B on March 13. This marks the first use of pad B since it served as the launch pad for Columbia (STS-40) last June.

A flight readiness firing (FRF) was conducted on April 6 in which Endeavour's three main engines were fired for 22 seconds. The FRF is a required test of all new Shuttles to verify the integrated operation of the three main engines, the main propulsion system and pad propellant delivery systems.

Following a review of the information from Endeavour's FRF, two irregularities were identified in two of the high pressure oxidizer turbo pumps on engines 1 and 2. Shuttle managers decided on April 8 to replace all three main engines at the launch pad with three spares. The decision to replace the engines was dictated by prudence and the fact that the work was expected to have little impact on the launch preparation schedule. The engines were replaced the following week.

Extensive post-FRF inspections of Endeavour's main propulsion system were performed as well as required tests of the main engines to make sure all systems are flight ready.

STS-49 payload elements, the perigee kick motor and the ASEM multi-purpose experiment support structure were scheduled to be installed in Endeavour's payload bay at the launch pad on April 14.

Routine operations and tests are planned while at the launch pad. This includes the Terminal Countdown Demonstration Test with the STS-49 flight crew, which was scheduled for April 16-17.

A standard 43-hour launch countdown is scheduled to begin 3 days prior to launch. During the countdown, the orbiter's fuel cell storage tanks will be loaded with fuel and oxidizer and all orbiter systems will be prepared for flight.

About 9 hours before launch, the external tank will be filled with its flight load of a half million gallons of liquid oxygen and liquid hydrogen propellants. About 2 1/2 hours before liftoff, the flight crew will begin taking their assigned seats in the crew cabin.

Endeavour's end-of-mission landing is planned at Edwards Air Force Base, Calif. Endeavour's landing will be the first Shuttle landing to use the new drag chute. STS-49 astronauts will manually deploy the chute after the nose gear has touched down. KSC's landing and recovery teams will be on hand to prepare the vehicle for the cross-country ferry flight back to Florida.

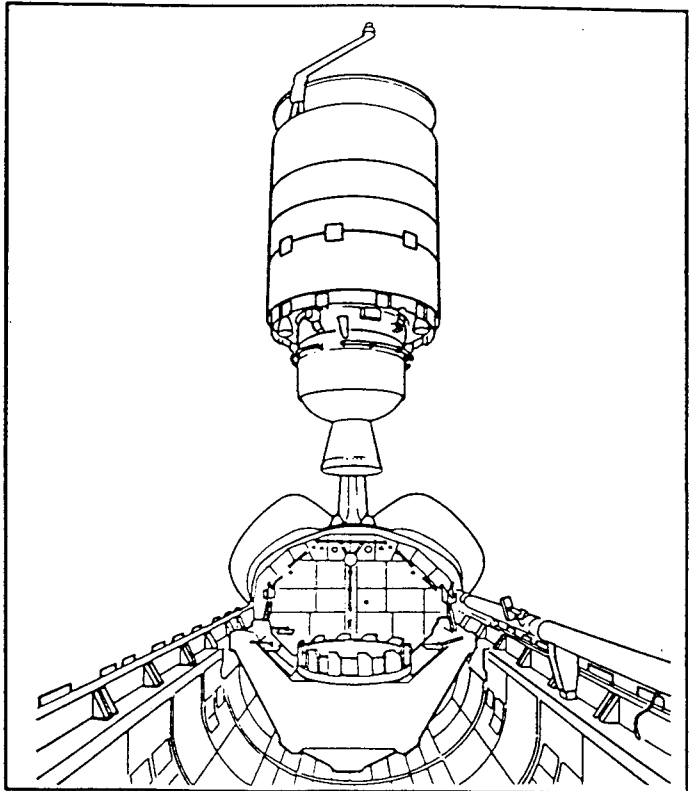
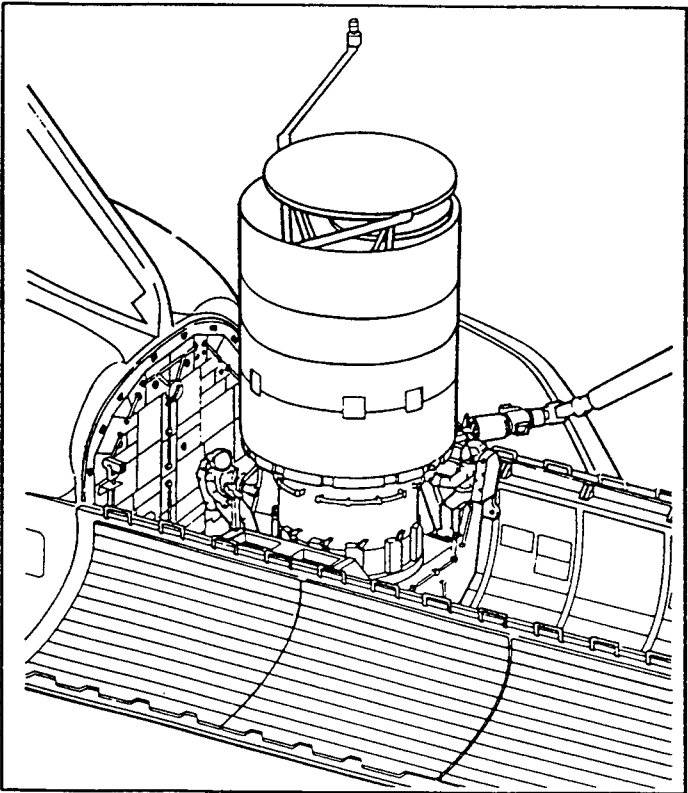
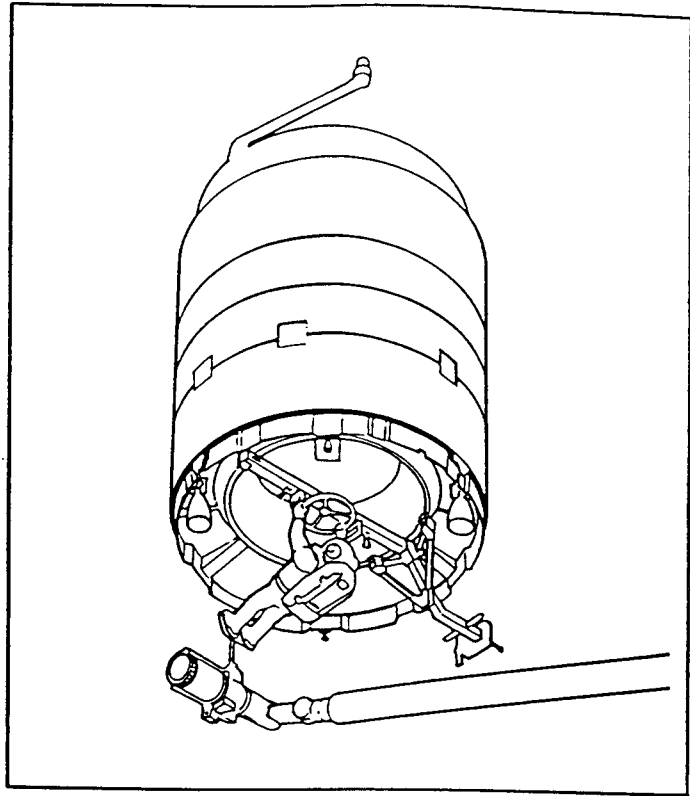
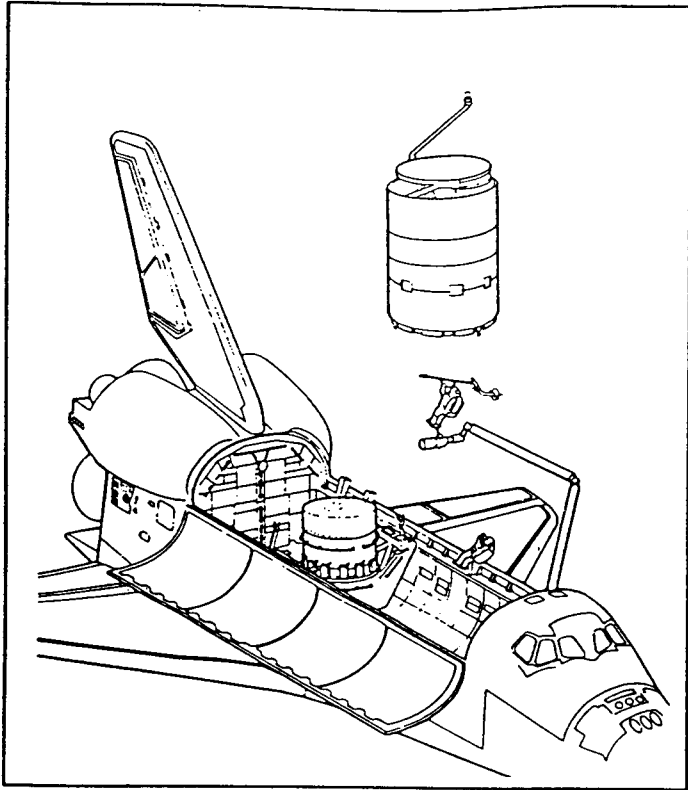
### **INTELSAT VI RENDEZVOUS, CAPTURE AND DEPLOY**

Endeavour will rendezvous with INTELSAT VI on flight day four of STS-49. INTELSAT-VI is currently in an orbit of approximately 299 n.m. by 309 n.m. Within 46 hours after Endeavour's launch, satellite controllers in Washington, D.C. will maneuver INTELSAT so that its orbit moves within a "control box" area within 6 degrees of arc of a 200 n.m. by 210 n.m., 28.35 degree inclination orbit. In addition, the controllers will slow the satellite's rotation from 10.5 to about 0.65 revolutions per minute.

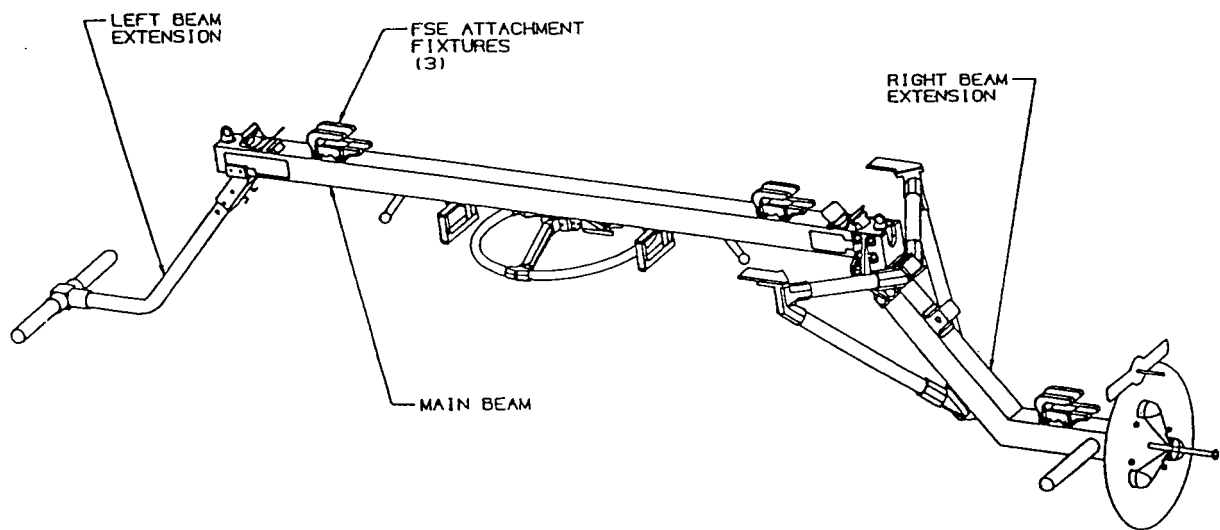
As Endeavour approaches INTELSAT in the final phase of rendezvous, crew members Pierre Thuot and Rick Hieb will begin a spacewalk to capture the satellite, install a perigee kick motor and deploy the satellite. The spacewalk is planned to begin about 1.5 hours prior to capture of the satellite.

As Endeavour closes in, Thuot will position himself on a foot restraint at the end of Endeavour's mechanical arm. From Endeavour's crew cabin, fellow crew member Bruce Melnick will maneuver the robot arm. As Endeavour holds a position in formation with the satellite, Melnick will move the arm and Thuot toward the slowly rotating INTELSAT. Once within reach, Thuot will install a specially designed "capture bar" on the aft end of the satellite in a soft attached mode. After it is soft attached, the attachment will be rigidized by Thuot with the installation of a locking device using a specially built power tool. Thuot will then manually halt the satellite's rotation using a special "steering wheel" on the capture bar. Once the satellite is stabilized, Melnick will grapple the INTELSAT with Endeavour's mechanical arm.

While Thuot is capturing the INTELSAT, Hieb will be preparing clamps and electrical connections in Endeavour's cargo bay for the satellite. Once INTELSAT has been grappled, Melnick will move the mechanical arm to position Thuot and the INTELSAT above the cargo bay, where Thuot will exit the foot restraint. The foot restraint then will be removed from the mechanical arm and Hieb will remove the steering wheel assembly and install an extension to the capture bar in preparation for docking INTELSAT to the new perigee kick motor located in Endeavour's cargo bay.



**REBOOST SEQUENCE** — left to right starting at the top, major points in the mission: (1) Astronaut approaches satellite with the capture bar. New motor and hardware can be seen resting in a cradle in the cargo bay. (2) Astronaut attaches capture bar, brings satellite back to cargo bay. (3) Once satellite is inside the shuttle, astronauts attach new hardware and boost motor. (4) Spacecraft with new motor is released from shuttle. When Endeavour is a safe distance away, the motor will be ignited to boost Intelsat VI to a 45,000-mile transfer orbit, from where it will be maneuvered into its proper position 22,300 miles above Earth.



**INTELSAT Capture Bar Assembly**

Melnick then will move the arm to position the satellite next to the motor's docking clamps. Thuot and Hieb will manually move the satellite into a final position within the four clamps, close the latches and attach two electrical umbilicals from the motor to INTELSAT. The capture bar will be released from INTELSAT and secured to the kick motor so that it will be jettisoned with the motor when the satellite reaches the proper altitude. Once all of the connections are completed, the spacewalkers will activate four springs that will eventually eject INTELSAT from the cargo bay.

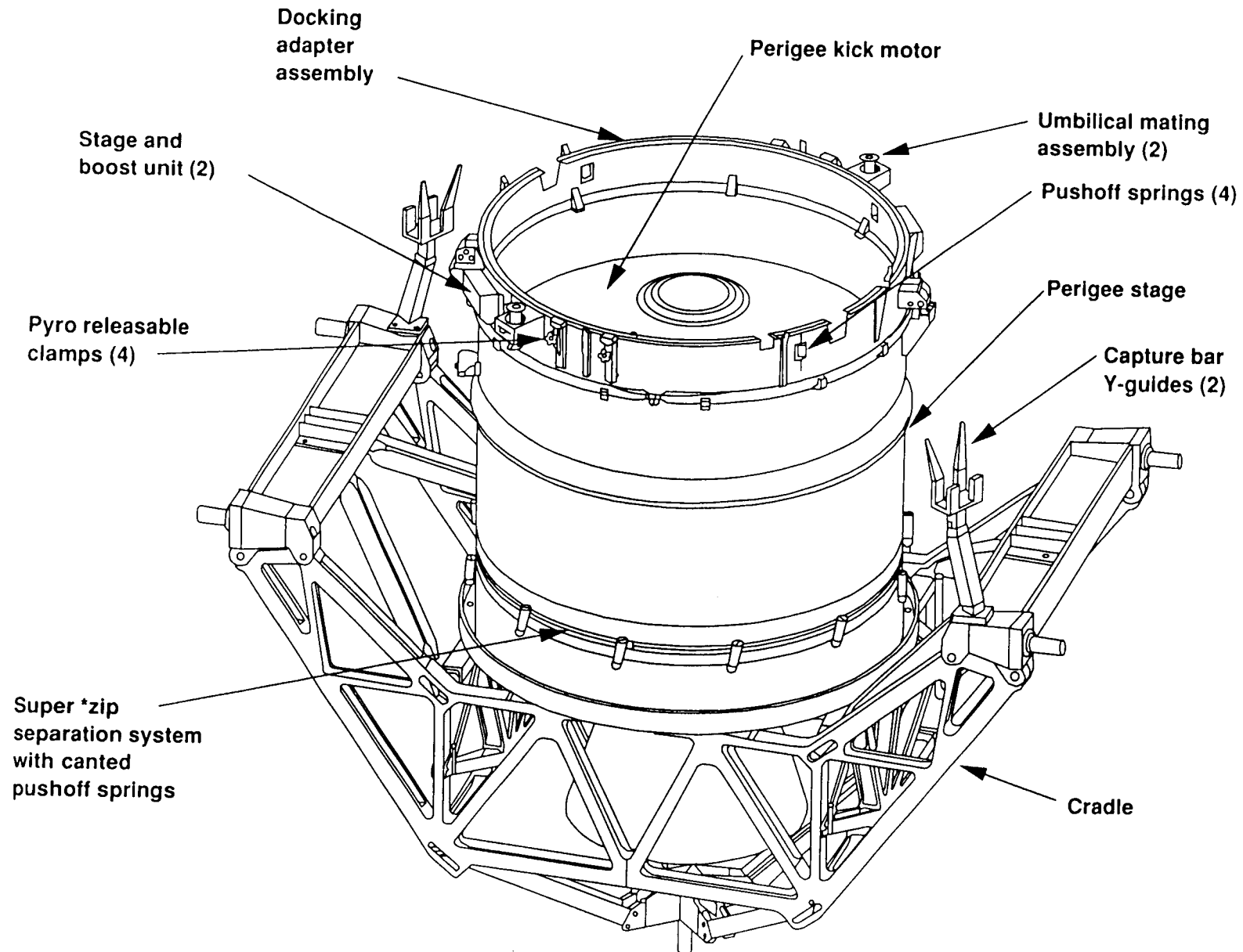
Thuot and Hieb will activate two timers for the solid rocket kick motor and move to Endeavour's airlock to await INTELSAT's ejection from the payload bay. After a switch is thrown from the aft flight deck of Endeavour, INTELSAT VI will be ejected by the springs at about 0.6 feet per second and with a slight rotation of about 0.7 revolutions per minute. After it has sufficiently cleared the orbiter, Endeavour will slowly back away. About 35 minutes later, satellite controllers will position INTELSAT for the motor firing and increase the spin rate.

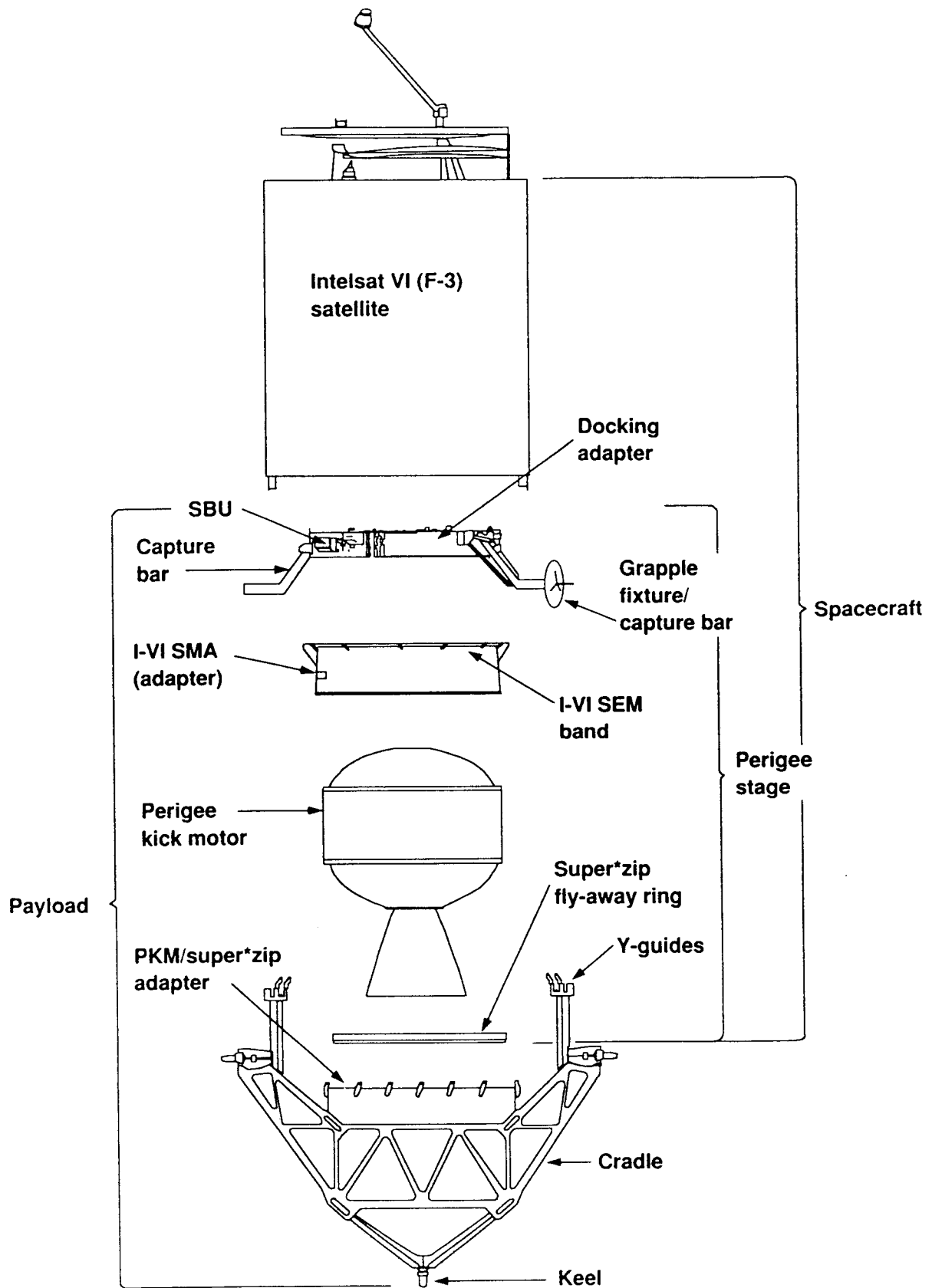
INTELSAT eventually will take position in geosynchronous orbit at an altitude of about 22,300 n.m. above the Atlantic Ocean. It is expected to be in full service by mid-1992.

### **INTELSAT-VI**

INTELSAT-VI (F-3) is a communications satellite of the International Telecommunications Satellite Consortium (INTELSAT), owned by 124 member nations and formed in the late 1960s to create a global telecommunications system. The system has a network of 17 satellites and the INTELSAT-VI series is the latest generation of satellites manufactured by Hughes Aircraft Co., El Segundo, Calif. The first INTELSAT-VI was launched in the fall of 1989. Three more successful launches followed. Of these, two are now in service over the Atlantic Ocean region and two above the Indian Ocean region. INTELSAT-VI (F-3) was launched on March 14, 1990, by a commercial Titan rocket. A launch vehicle malfunction left the Titan's second stage attached to the satellite, thus prohibiting the firing of a solid rocket motor that was to raise it to geosynchronous orbit. Satellite controllers later jettisoned the solid rocket motor with the Titan second stage attached and raised the satellite to its current orbit.

INTELSAT-VI (F-3) weighs about 8,960 pounds, has a diameter of 11.7 feet and a height of 17.5 feet. With its solar arrays fully deployed, the satellite's height will be almost 40 feet. Each satellite's expected operational lifetime is 10 years. It is designed to provide a variety of voice, video and data communications with 48 transponders powered by 2,600 watts of direct current. Two nickel-hydrogen batteries can supply power for short periods when solar power is unavailable as the satellite passes through Earth's shadow.





**INTELSAT VI F-3 REBOOST  
PAYLOAD LAYOUT**

## **INTELSAT-VI REBOOST EQUIPMENT**

Perigee Kick Motor (PKM) -- The perigee kick motor weighs 23,000 pounds, is 127.22 inches tall and 92.52 inches in diameter. It is an Orbus 215 solid propellant motor built by United Technologies Corp. and provided by Hughes Aircraft Co., El Segundo, Calif., for the mission.

Capture Bar Assembly -- The capture bar assembly was designed by engineers in the Crew and Thermal Systems Division, Johnson Space Center, Houston. It weighs 162 pounds, is 181.37 inches long, 40.75 inches tall and 37.38 inches wide. The capture bar has a detachable right beam extension, left beam extension and steering wheel. All of the capture bar equipment is constructed of aluminum and stainless steel.

Cradle -- The cradle holds the perigee kick motor in Endeavour's cargo bay during launch and weighs 3,749 pounds. It is constructed of aluminum and is 193 inches wide, 93.53 inches long and 151.48 inches tall. It was provided by Hughes Aircraft Co.

Docking Adapter -- The docking adapter allows attachment of the perigee kick motor to the INTELSAT-VI and weighs 152.8 pounds. It is 92.52 inches in diameter and 12 inches thick, constructed of aluminum with some stainless steel components.

## **ASSEMBLY OF SPACE STATION BY EVA METHODS**

STS-49 astronauts will venture out of the crew cabin two more times following the repair of INTELSAT VI. The objective of the second EVA, performed by Thornton and Akers, and the third spacewalk, performed by Thuot and Hieb, will be to demonstrate and verify Space Station Freedom maintenance and assembly tasks.

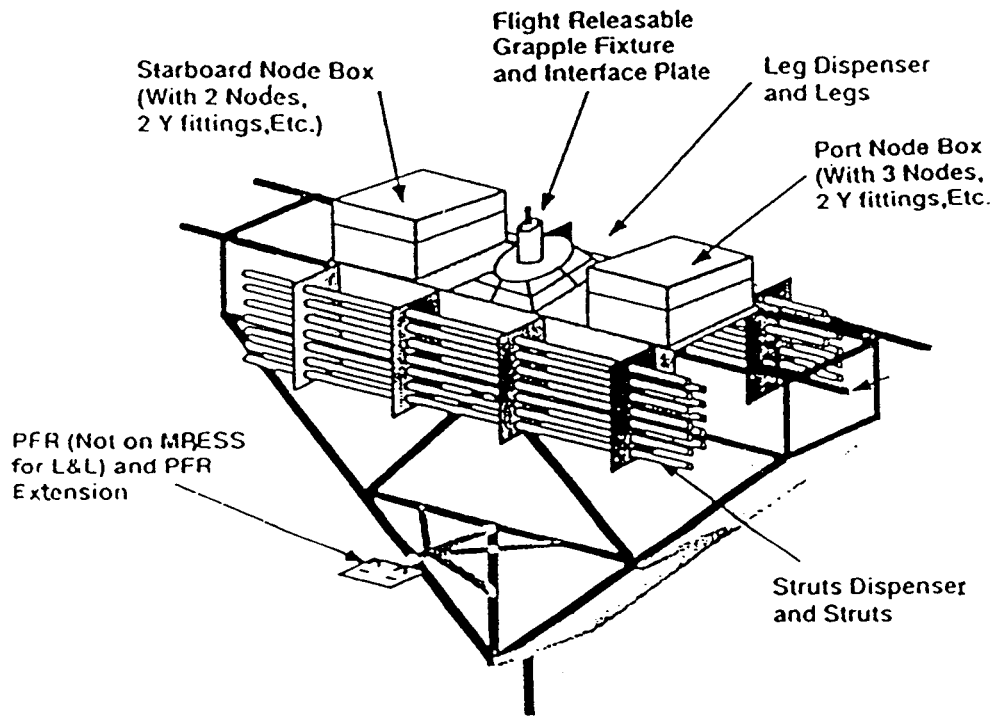
The Assembly of Station by Extravehicular Activity Methods (ASEM) evaluation consists of hardware and techniques to construct a partial truss structure bay. Crew members will build a truss pyramid; unberth, maneuver and berth the Multiple Purpose Experiment Support Structure (MPRESS) pallet to assess the mass handling capabilities of an EVA astronaut; and evaluate the ability to work with the mechanical arm at positions above and forward of the Shuttle's cargo bay.

The MPRESS, located in the forward payload bay, will house two node boxes for the truss pyramid; a releasable grapple fixture and interface plate; a truss leg dispenser and legs and strut dispenser; and the struts for the truss pyramid.

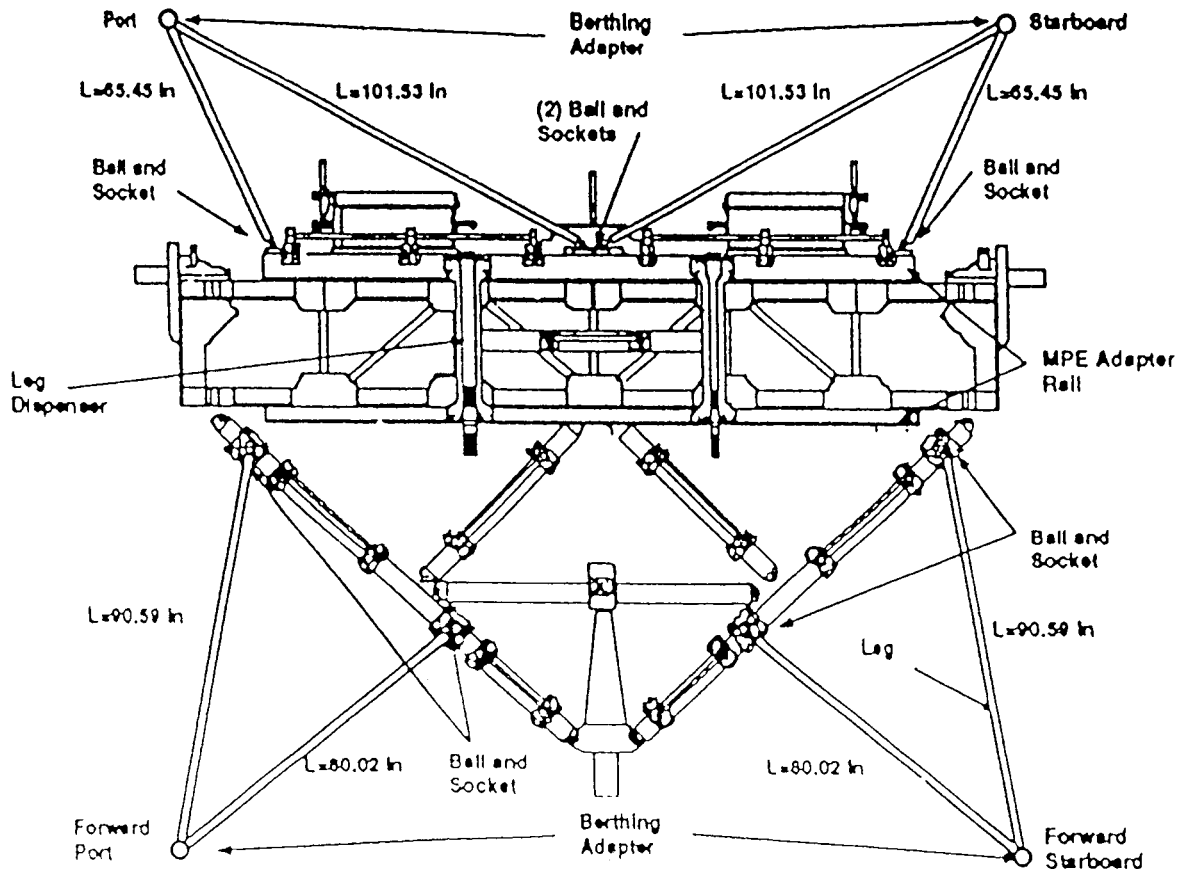
Other tests will evaluate the assembly area and MPRESS berthing operations guided by the spacewalker and a spacesuit-mounted camera. The three consecutive days of spacewalks will evaluate the capability to perform day-after-day spacewalks by a variety of astronauts, a procedure that will be needed to build Space Station Freedom.

# Stowage Subsystem (MPESS)

20

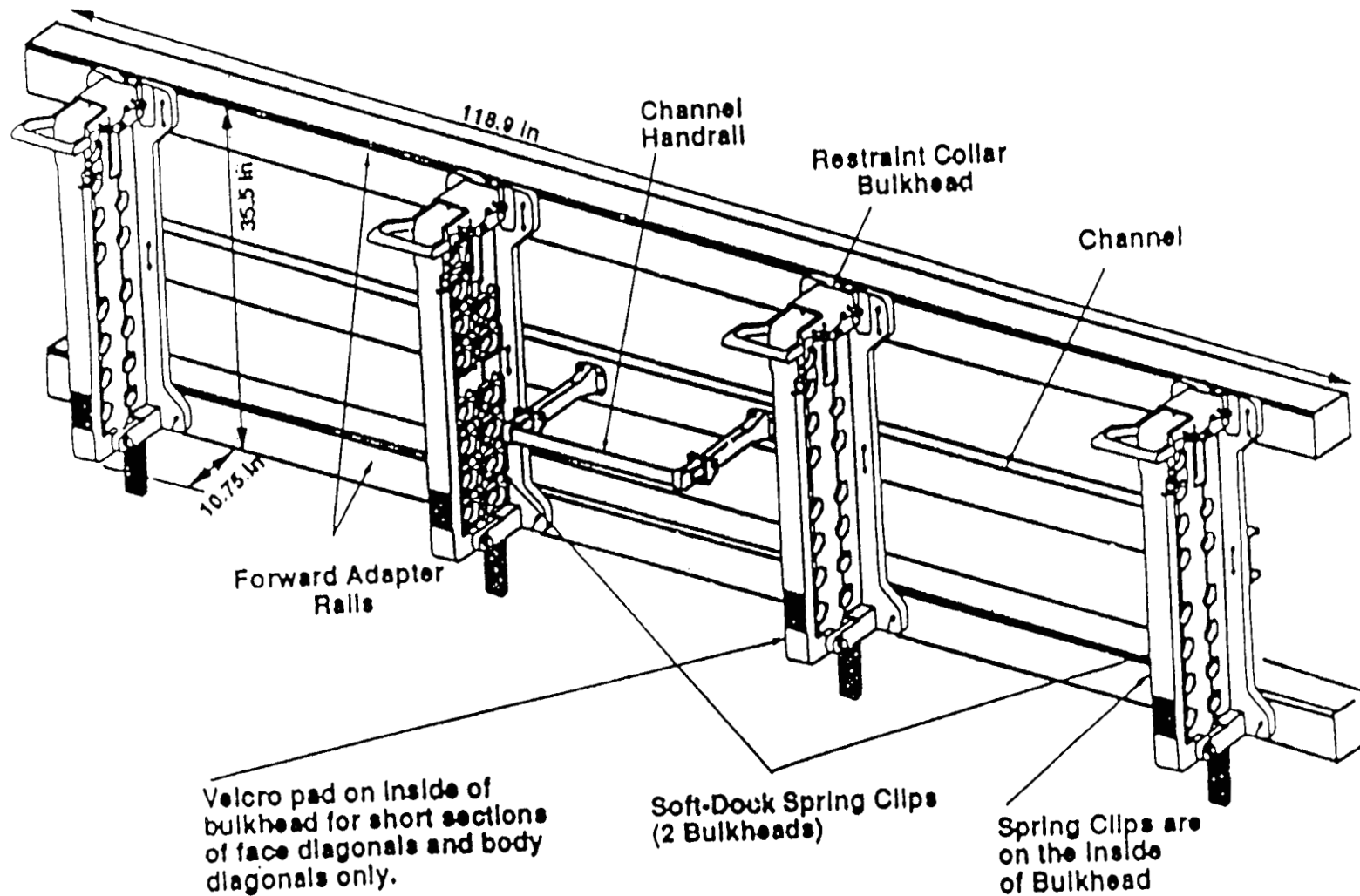


## ASEM MPESS with Legs Attached



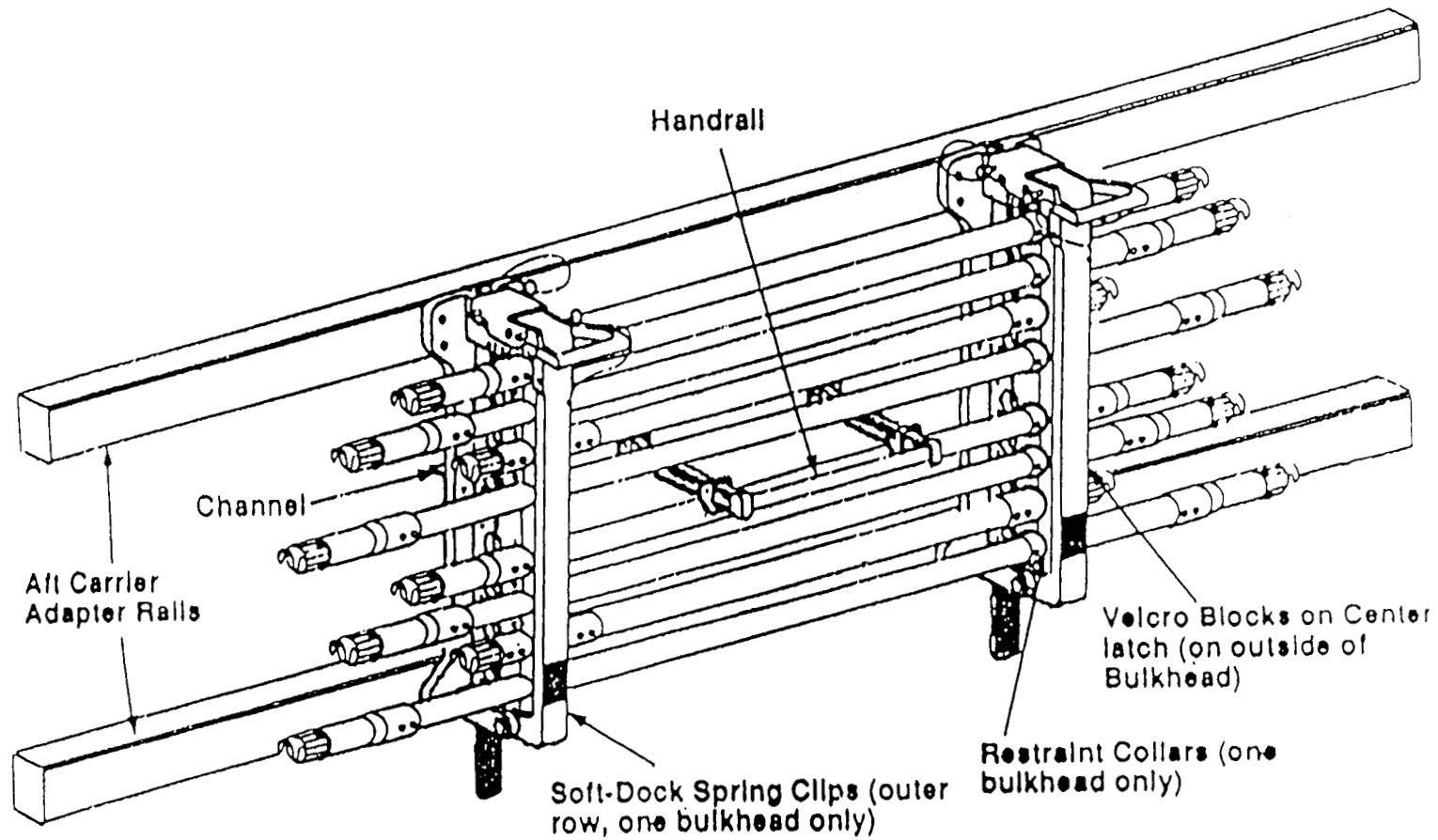
# Strut Dispenser

(Struts not shown)

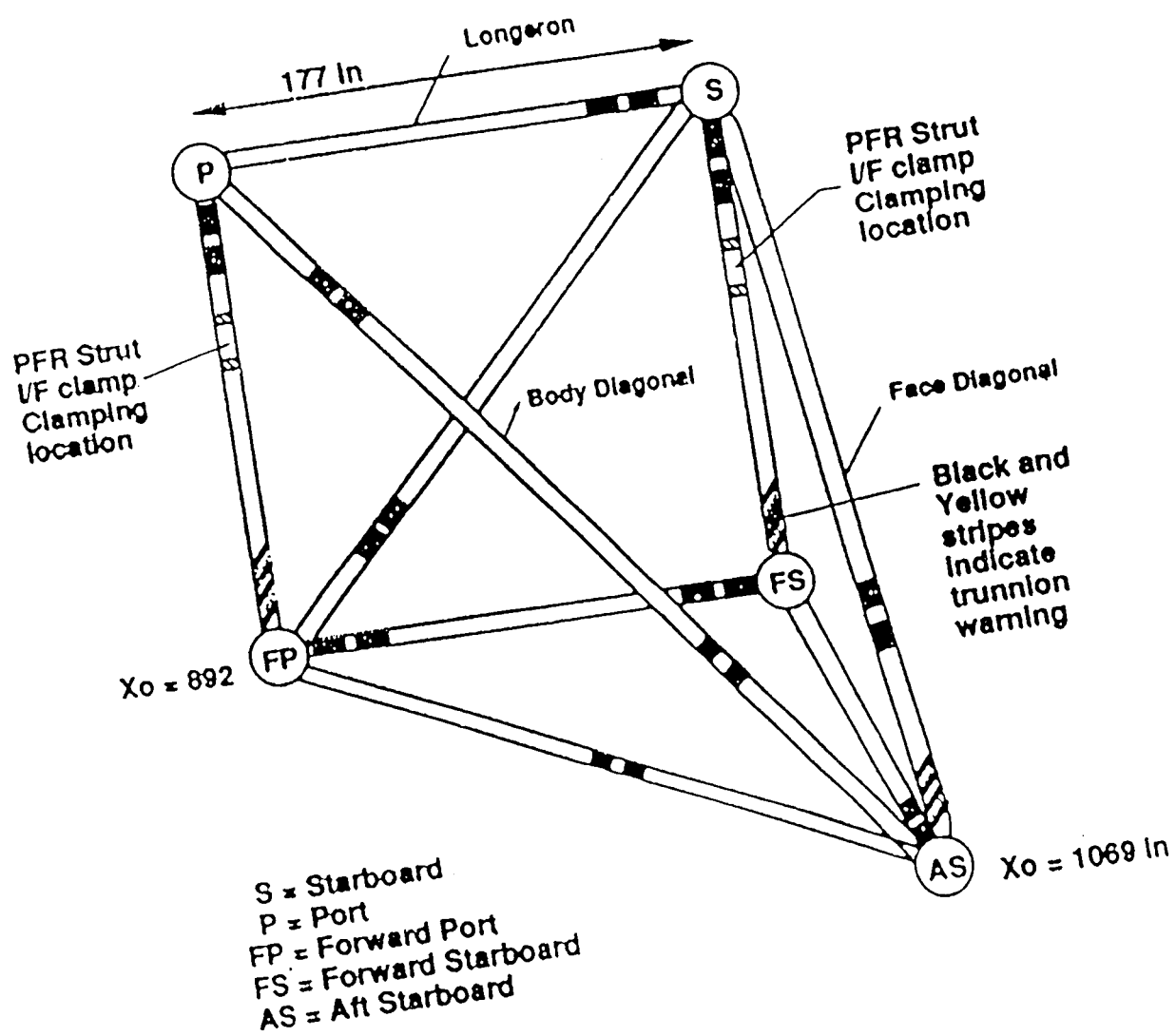


# Leg Dispenser

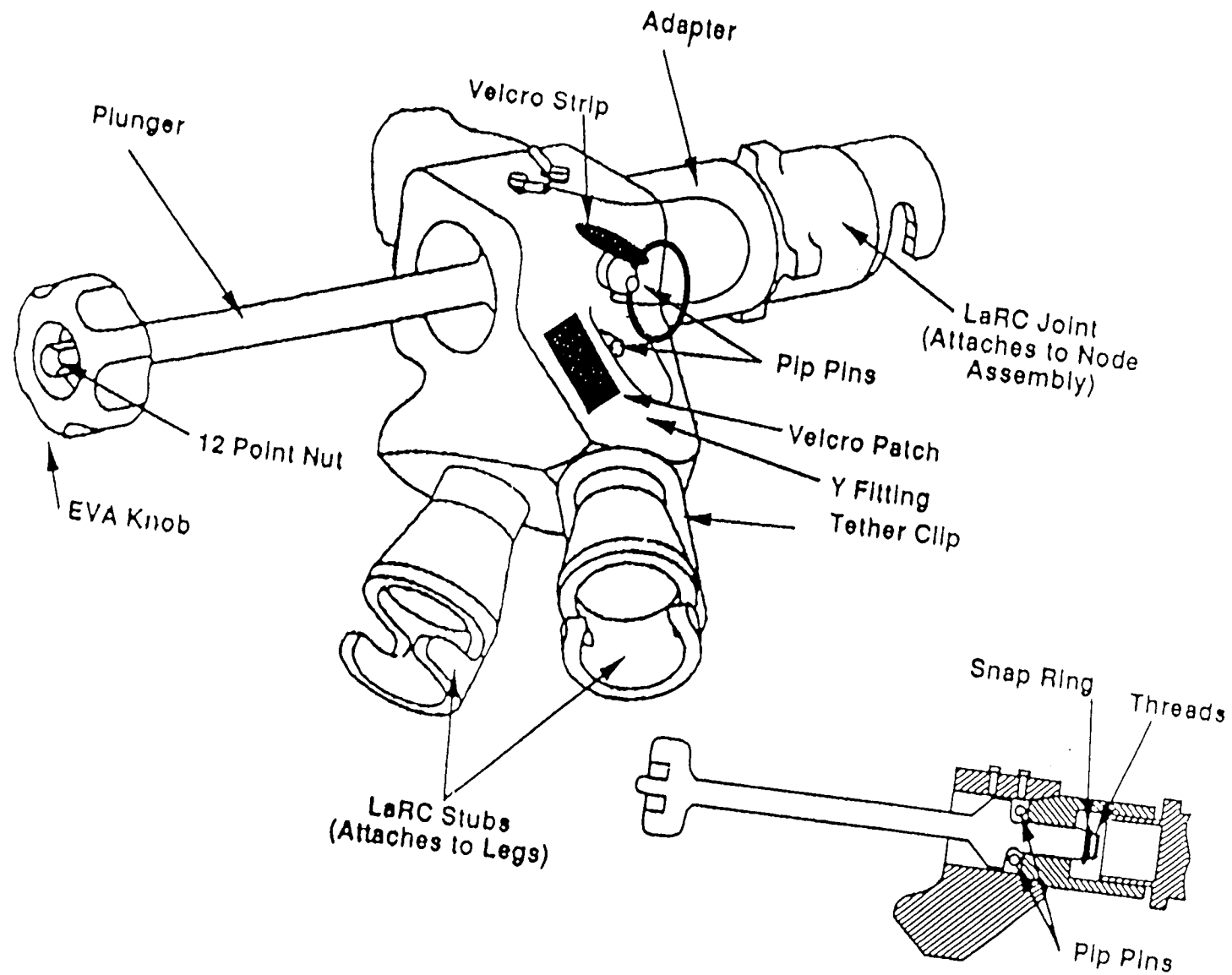
(Legs shown)



# ASEM Attachment Fixture

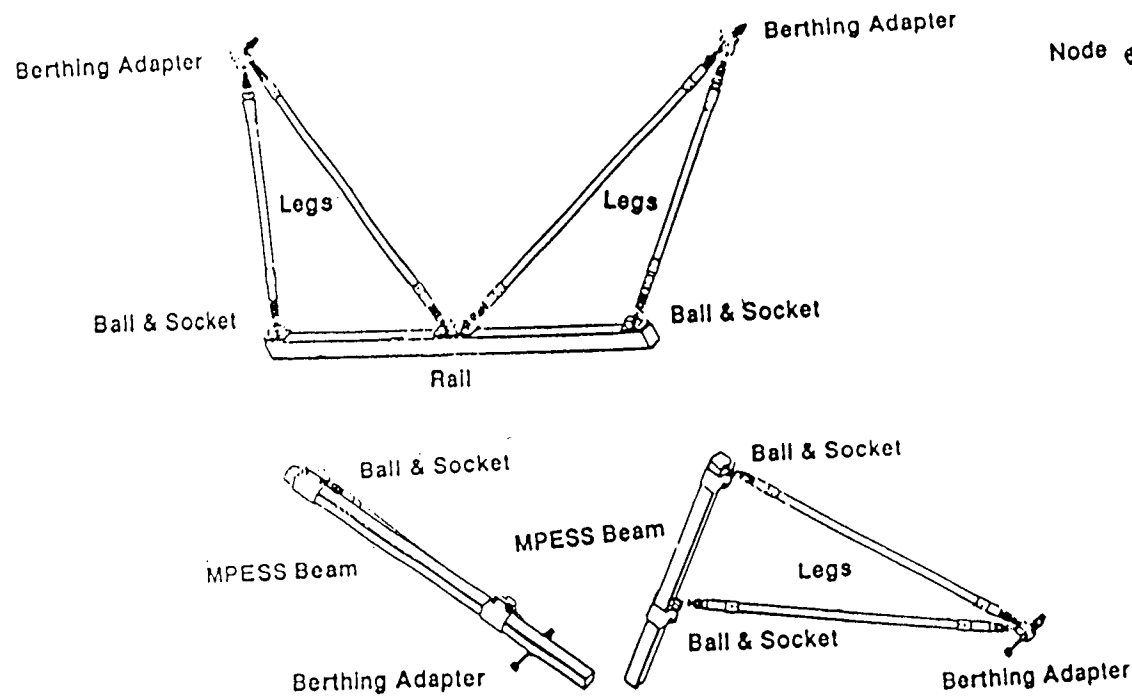


# ASEM Berthing Adapter

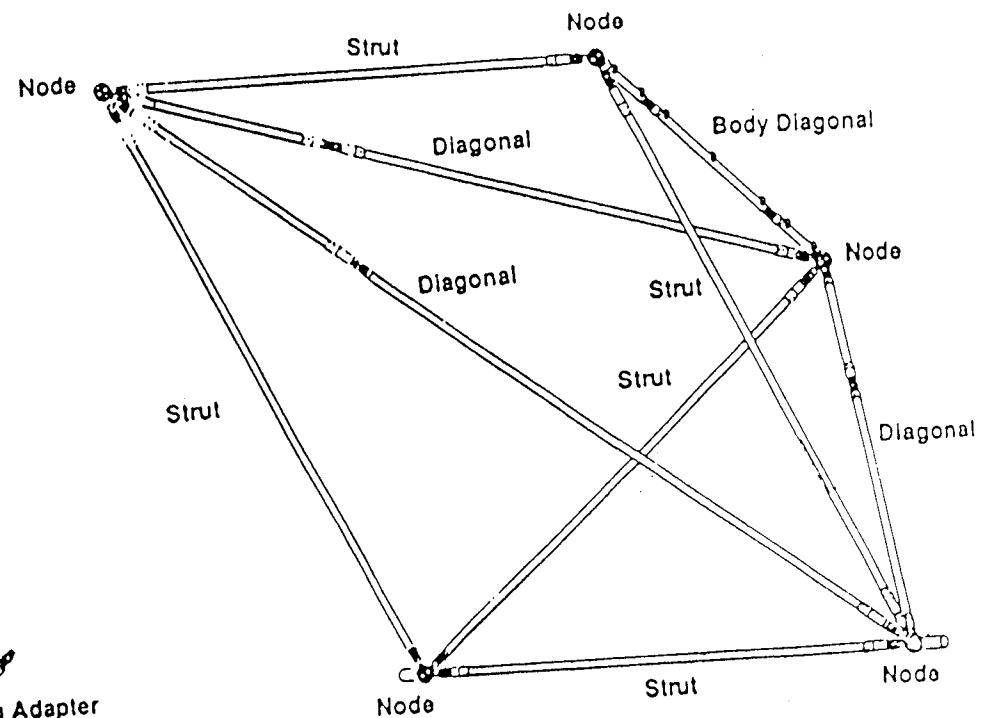


# Assembly of Station by EVA Methods (ASEM)

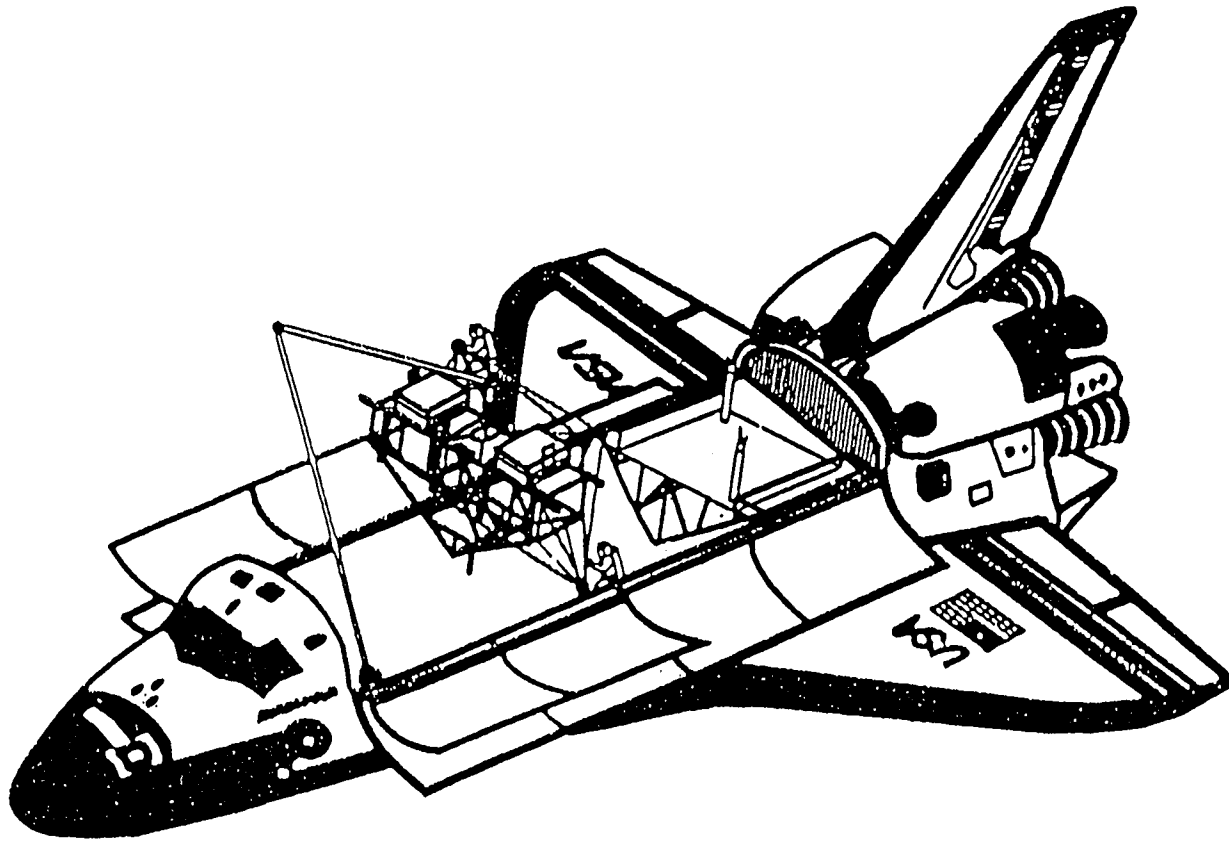
## Carrier Attach Subsystem



## Attachment Fixture Subsystem



## ASEM On-Orbit Configuration



Another of the ASEM drills will be a demonstration of crew rescue device prototypes. Five concepts will be tested by all of the spacewalkers -- the astrorope, telescopic pole, bi-stem pole, inflatable pole and the crew propulsive device.

The astrorope uses an approach similar to the concept of a bola-type lasso. It is comprised of two cleats attached to a Kevlar cord. The astrorope is thrown by hand and is meant to wrap around an element of the space station structure. The astrorope must be manually retracted prior to throwing it again and has an effective reach range of about 20 feet.

The telescopic pole uses a design similar to a telescoping radio antenna. It has a grapple fixture on the end and seven sections that can be manually extended. This concept would allow an unlimited number of grapple attempts and reaches up to 12 feet.

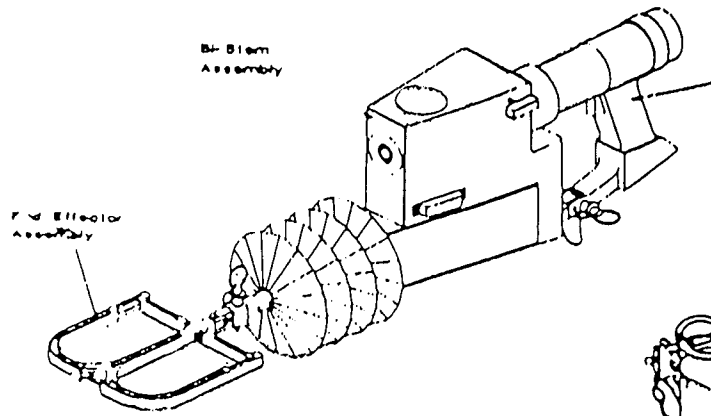
The bi-stem pole consists of two thin strips of spring steel which, when allowed to return to their equilibrium state during deployment, overlap one another to form a rigid pole. It has a grapple fixture attached to one end and would be used with a power tool for extension and retraction. This powered approach design also is capable of unlimited grapple attempts. Its reach range is about 20 feet.

The inflatable pole uses a tubular sock that when pressurized forms a rigid pole. It has a grapple fixture attached to the end and can accomplish unlimited grapple attempts. Once it is attached, the sock is deflated and a hand-over-hand reapproach can be performed. This design does not allow reuse and has a reach range of 15 feet.

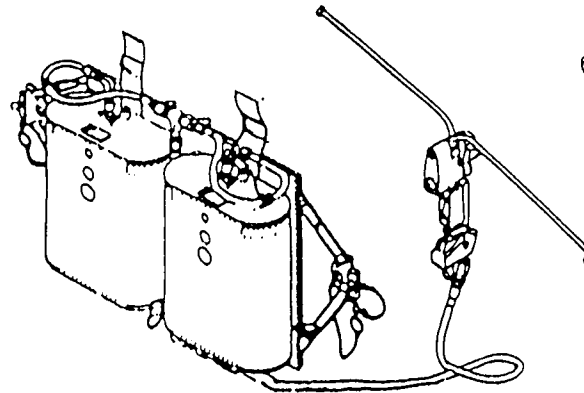
The crew propulsive device is essentially a redesigned handheld maneuvering unit from the Skylab program. The device can be unfolded and small jets are used as thrusters, powered by a small canister of pressurized nitrogen. Using a powered reapproach, its reach range is limited by its nitrogen supply.

Only three of the concepts have spacewalk time dedicated to them -- the crew propulsive device, the bi-stem and the inflatable pole -- and will take place on flight days 5 and 6. The astrorope and the telescoping pole concepts will be evaluated as time permits during the spacewalks. The crew self rescue hardware was developed by the Crew and Thermal Systems Division at the Johnson Space Center.

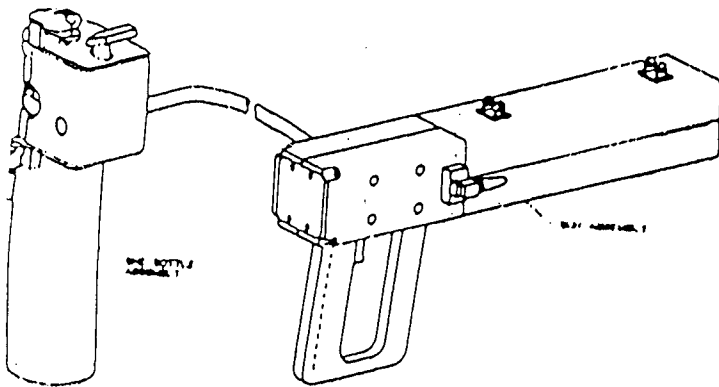
# Crew Self Rescue Hardware



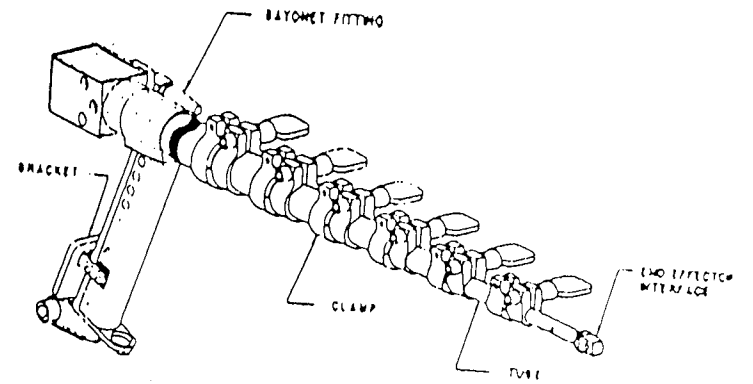
BI-Stem Pole



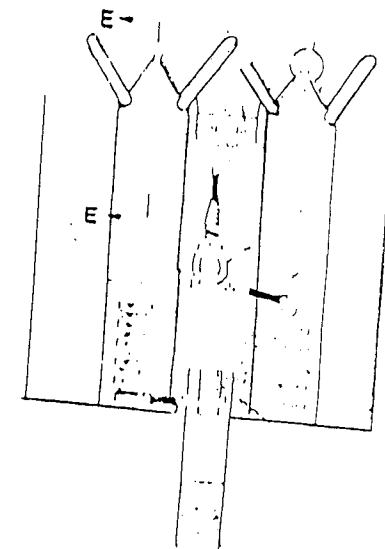
Crew Propulsive Device



Inflatable Pole



Telescopic Pole



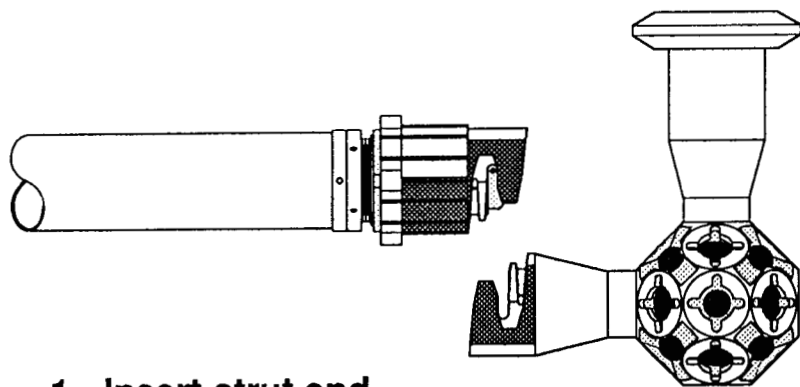
Astro-Rope

## **Langley Truss Joint Used in ASEM Flight Experiment**

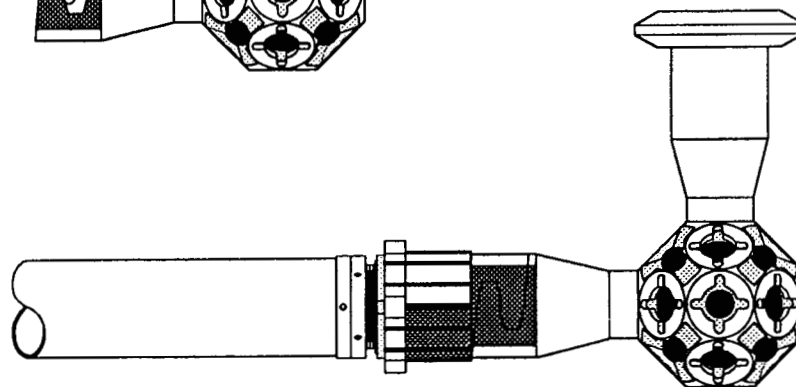
During the ASEM flight experiment, astronauts will assemble a truss structure segment using an advance truss joint, designed and fabricated at the NASA Langley Research Center, Hampton, Va.. The truss joint (see illustration) is easily operated without the aid of tools and provides a strong and stiff connection between truss components. The truss joint, which only requires the simple rotation of a collar to lock, was designed to be operated either manually by the astronauts or robotically if required in future applications. The joint which measures approximately 2 inches in diameter, has been tested extensively by the astronauts on the ground and in neutral buoyancy, and their evaluations have lead to improvements in the design. However, the ASEM flight experiment will be the first time a truss structure has been assembled in space using this truss joint.

This truss joint is a key product of an extensive NASA Langley Research Center program to develop the technology for efficient on-orbit construction of spacecraft which are too large to be boosted into orbit intact. It was selected as the baseline structural joint for the original larger, erectable Space Station Freedom design. The joint components are produced at Langley Research Center on numerically controlled machine tools for accuracy and economy and are made of a high strength aluminum alloy. A total of 137 strut end joint assemblies were supplied to the Johnson Space Center, which permitted assembly of the three sets of experimental hardware required for neutral buoyancy training certification and flight.

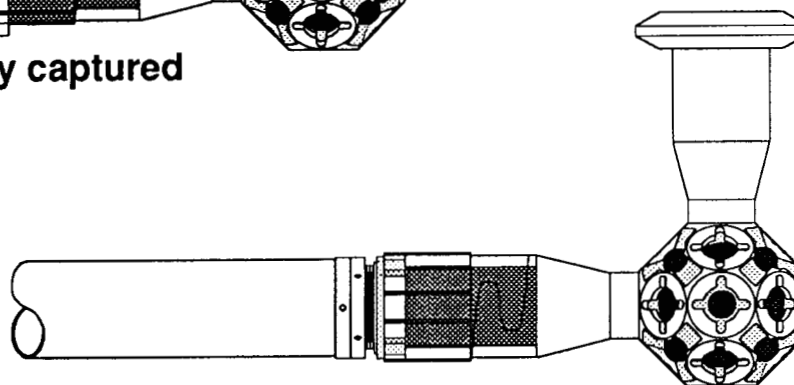
## SPACE STATION JOINT ATTACHMENT SEQUENCE



1 - Insert strut end



2 - Strut end automatically captured



3 - Rotate collar to lock and preload joint

## COMMERCIAL PROTEIN CRYSTAL GROWTH EXPERIMENT

In the past decade, exponential growth in the use of protein pharmaceuticals has resulted in the successful use of proteins in insulin, interferons, human growth hormone and tissue plasminogen activator. Pure protein crystals are facing an increase in demand by the pharmaceutical industry because such purity will facilitate Federal Drug Administration approval of new protein-based drugs. Pure, well-ordered protein crystals of uniform size are in demand by the pharmaceutical industry as special formulations for use in drug delivery.

During the past 6 years, a variety of hardware configurations have been used to conduct Protein Crystal Growth (PCG) experiments aboard 12 Space Shuttle flights. These experiments have involved minute quantities of sample materials to be processed. On STS-49, the Protein Crystallization Facility (PCF), developed by the Center for Macromolecular Crystallography (CMC), a NASA Center for the Commercial Development of Space at the University of Alabama-Birmingham, will use much larger quantities of materials to grow crystals in batches, using temperature as a means to initiate and control crystallization.

The PCF has been reconfigured to include cylinders with the same height, but varying diameters to obtain different volumes (500, 200, 100, 20 ml). These cylinders allow for a relatively minimal temperature gradient and require less protein solution to produce quality crystals. This is an industry-driven change brought about by a need to reduce the cost and amount of protein sample needed to grow protein crystals in space, while at the same time increasing the quality and quantity of crystals.

Also flying on STS-49 as part of the CPCG payload complement is a newly-designed, "state-of-the-art" Commercial Refrigerator Incubator Module (CRIM) which allows for a pre-programmed temperature profile. The CRIM temperatures are programmed prior to launch and a feedback loop monitors CRIM temperatures during flight. Developed by Space Industries, Inc., Webster, Texas, for CMC, the CRIM also provides improved thermal capability and has a microprocessor that uses "fuzzy logic" (a branch of artificial intelligence) to control and monitor the CRIM's thermal environment. A thermoelectric device is used to electrically "pump" heat in or out of the CRIM.

The PCF serves as the growth chamber for significant quantities of protein crystals. Each of the PCF cylinders on STS-49 is encapsulated within individual aluminum containment tubes and supported by an aluminum structure. Prior to launch, the cylinders will be filled with bovine insulin solution and mounted into a CRIM set at 40 degrees C. Each cylinder lid will pass through the left wall of the aluminum structure and come into direct contact with a metal plate in the CRIM that is temperature-controlled by the thermoelectric device.

Shortly after achieving orbit, the crew will activate the PCF experiment by initiating the pre-programmed temperature profile. The CRIM temperature will be reduced automatically from 40 degrees C to 22 degrees C over a 4-day period. The change in CRIM temperature will be transferred from the cold plate through the cylinders' lids to the insulin solution.

Decreasing the temperature of the solution by 18 degrees C will effect the resulting crystals' formation, which should be well ordered due to the reduced effects the Earth's gravity. Once activated, the payload will not require any further crew interaction (except for periodic monitoring), nor will it require any modifications for landing.

In general, purified proteins have a very short lifetime in solution; therefore, the CPCG payload and CRIM will be loaded onto the Shuttle no earlier than 24 hours prior to launch. Due to the instability of the resulting protein crystals, the CRIM will be retrieved from the Shuttle within 3 hours of landing. The CRIM will be battery-powered continuously from the time the samples are placed in the CRIM and it is loaded onto the Shuttle, until the time it is recovered and delivered to the investigating team. For launch delays lasting more than 24 hours, the payload will need to be replenished with fresh samples.

Once the samples are returned to Earth, they will be analyzed by morphometry to determine size distribution and absolute/relative crystal size. They also will be analyzed with X-ray crystallography and biochemical assays of purity to determine internal molecular order and protein homogeneity, respectively.

The Commercial Protein Crystal Growth payload, sponsored by NASA's Office of Commercial Programs, is developed and managed by the Center for Macromolecular Crystallography. Dr. Charles E. Bugg, Director, CMC, is lead investigator for the CPCG experiment. Dr. Marianna Long, CMC Associate Director for Commercial Development also is a CPCG investigator.

### **AIR FORCE MAUI OPTICAL SYSTEM (AMOS)**

The AMOS is an electrical-optical facility located on the Hawaiian island of Maui. The facility tracks the orbiter as it flies over the area and records signatures from thruster firings, water dumps or the phenomena of "Shuttle glow," a well-documented glowing effect around the orbiter caused by the interaction of atomic oxygen with the spacecraft. The information obtained is used to calibrate the infrared and optical sensors at the facility. No hardware onboard the Shuttle is needed for the system.

## **SPACE SHUTTLE ENDEAVOUR (OV-105)**

### **Construction of endeavour**

Rockwell International's Space Systems Division (SSD) received authority to proceed with construction of a fifth Space Shuttle orbiter -- designated OV-105 -- from NASA on Aug. 1, 1987. OV-105 is the replacement orbiter for OV-099 which was lost in the Space Shuttle Challenger accident.

Rockwell managed the OV-105 construction program under the direction of NASA's Johnson Space Center. The division fabricated the orbiter's forward and aft fuselages, forward reaction control systems, crew compartment and secondary structures at its Downey, Calif., headquarters facility. Final assembly, test and checkout took place at Rockwell's orbiter assembly facility in Palmdale, Calif. In addition, more than 250 major subcontractors and thousand of associated suppliers across the nation performed work on Shuttle components and support services, which accounted for nearly 50 percent of the total work on the program. OV-105 was officially turned over to NASA on April 25, 1991 at a ceremony at Rockwell's Palmdale facility.

### **IMPROVED FEATURES OF SPACE SHUTTLE ENDEAVOUR**

Many systems onboard Endeavour have had design changes or have been updated from earlier equipment to take advantage of technological advances and continue improvements to the Space Shuttle. The upgrades include several improved or redesigned avionics systems; installation of a drag chute as part of a series of landing aid additions to the orbiters; and modifications to pave the way for possibly extending Shuttle flights to last as long as 3 weeks in the future.

Some such updated systems already have been installed in the rest of the shuttle orbiters as well as Endeavour; some will be installed in all orbiters in the near future; and others will be used on Endeavour only.

### **UPDATED AVIONICS SYSTEMS**

#### **Advanced General Purpose Computers**

The advanced general purpose computers (GPCs) are now in the process of being incorporated into the entire orbiter fleet and will be installed and used on Endeavour for its first space flight. The updated computers have more than twice the memory and three times the processing speed of their predecessors. Officially designated the IBM 10-101S, built by IBM, Inc., they are half the size, about half the weight and require less electricity than the first-generation GPCs. The central processor unit and input/output processor, previously installed as two separate boxes, are now a single unit.

The new GPCs use the existing Shuttle software with only subtle changes. However, the increases in memory and processing speed allow for future innovations in the Shuttle's data processing system. Although there is no real difference in the way the crew will operate with the new computers, the upgrade increases the reliability and efficiency in commanding the Shuttle systems. The predicted "mean time between failures" (MTBF) for the advanced GPCs is 6,000 hours. The flight computers are already exceeding that prediction with an MTBF of 18,500 hours. The MTBF for the original GPCs is 5,200 hours.

#### New GPC Specifications

Dimensions:	19.52" x 7.62" x 10.2"
Weight:	64 lbs.
Memory Capacity:	262,000 words (32-bits each)
Processing Rate:	1.2 million instructions per second
Power Requirements:	550 watts

#### HAINS Inertial Measurement Units

The High Accuracy Inertial Navigation System (HAINS) Inertial Measurement Unit (IMU) will be incorporated into the orbiter fleet on an attrition basis as replacements for the current KT-70 model IMUs. The three IMUs on each Shuttle orbiter are four-gimbal, inertially stabilized, all-attitude platforms that measure changes in the spacecraft's speed used for navigation and provide spacecraft attitude information on flight control.

For Endeavour's first flight, one HAINS IMU will fly with two accompanying DT-70 IMUs to provide redundancy with proven hardware. The HAINS IMU for the Space Shuttle is a derivative of IMUs used in the Air Force's B-1B aircraft. It includes an improved gyroscope model and microprocessor and has demonstrated in testing improved abilities to hold an accurate alignment for longer periods of time. In addition, it has proven more reliable than the KT-70 IMUs. The new IMUs require no software changes on the orbiter or changes in electrical or cooling connections. The HAINS IMU is manufactured by Kearfott, Inc., of Little Falls, N.J.

#### Improved Tactical Air Navigation Systems

A complete set of three improved TACANS will fly on Endeavour's first flight. The improved TACAN is a modified off-the-shelf unit developed by Collins, Inc., of Cedar Rapids, Iowa, for military aircraft and slightly modified for the Shuttle. The improved TACAN operates on 28-volt direct current electricity as compared to the current TACANS that use 110-volt alternating current for power. Also, the new TACANS do not require forced air cooling as do the current TACANS.

The TACANS' connections to the Shuttle's guidance, navigation and control system are identical. The TACANS provide supplemental navigational information on slant range and bearing to the orbiter using radio transmissions from ground stations during the final phases of entry and landing.

### **Enhanced Master Events Controller (EMEC)**

The EMEC features improved reliability, lower power usage and less maintenance than current MECs. The new design uses 30 percent less electricity and has more internal backup components. The MECs, two aboard each Shuttle, are a relay for onboard flight computers used to send signals to arm and fire pyrotechnics that separate the solid rockets and external tank during ascent. The EMEC were built by Rockwell's Satellite Space Electronics Division, Anaheim, Calif. Present plans call for Endeavour to be the only orbiter with the EMECs.

### **Mass Memory Unit Product Improvement**

Improvements to the current MMUs in the form of modifications include error correction and detection circuitry to accommodate tape wear, tape drive motor speed reduction to extend the tape's lifetime. In addition, modifications were made to the tape drive head to extend its lifetime. The improvements have no effect on the current software or connections of the MMUs. Two MMUs are on each orbiter and are a magnetic reel-to-reel tape storage device for the Shuttle's onboard computer software. The modification to the MMUs will be done for the first flight of Endeavour and for the rest of the orbiter fleet during normal maintenance activities. The MMUs were built and upgraded by Odetics of Anaheim, Calif.

### **Enhanced Multiplexer-Demultiplexer**

The EMDM uses state-of-the-art components to replace obsolete parts and improve maintenance requirements. The new components have simplified the structure of the EMDM by more than 50 parts in some instances. The EMDMs are installed on Endeavour, but plans have not been made to replace the current MDMs in other orbiter. The MDMs, 19 located throughout each orbiter, act as a relay for the onboard computer system as it attains data from the Shuttle's equipment and relays commands to the various controls and systems. The EMDMs are manufactured by Honeywell Space Systems Group, Phoenix, Ariz.

### **Radar Altimeter**

The improved radar altimeter aboard Endeavour already has been installed and flown on all other Shuttle orbiters since STS-26. The altimeter is an off-the-shelf model originally developed for the military's cruise missile program. The altimeter has the capability to automatically adjust its gain control as a function of changes in altitude. Along with anti-false lock circuitry, the improvements have eliminated a problem frequently experienced with the original radar altimeter caused by interference from the Shuttle's nose landing gear. The radar altimeter is built by Honeywell, Minneapolis.

## **Improved Nosewheel Steering**

Improvements to the nosewheel steering mechanisms include a second command channel, used as a backup in case of a failure in the primary channel, for controlling the steering through the onboard computers. In addition, a valve has been installed in the hydraulic system to switch in a secondary hydraulic pressure system in case of a failure in the primary system. Endeavour will have the modifications prior to its first flight, and the rest of the orbiter fleet will have the improvements made during their major modifications periods. The improved nosewheel steering was designed by Sterer Engineering and Manufacturing Components, Los Angeles.

## **Solid State Star Tracker**

The SSST is a new star tracker design developed for Endeavour which takes advantage of advances in star tracker technology. The two star trackers on each Shuttle orbiter are used to search for, detect and track selected guide stars to precisely determine the orientation of the spacecraft. The precise information is used to periodically update the orbiter's IMUs during flight. The SSST uses a solid state charge coupled device to convert light from stars into an electric current from which the star's position and intensity are determined. The solid state design consumes less electricity and provides greater reliability than the current star trackers. The SSSTs require no modification to the orbiter or its software for installation. Current plans are for one SSST to be installed on Endeavour and another to be incorporated into the orbiter fleet on an attrition basis. The SSST was developed and built by Ball Aerospace Division, Boulder, Colo.

## **UPDATED MECHANICAL SYSTEMS**

### **Improved Auxiliary Power Units**

An improved version of the APUs, three identical units that provide power to operate the Shuttle's hydraulic system, has been installed on Endeavour. The IAPUs will be installed on the rest of the orbiter fleet as each spacecraft is taken out of operation for a major modification period during the next 2 years.

The IAPU is lighter than the original system, saving about 134 pounds. The weight savings are due to the use of passive cooling for the IAPUs, eliminating an active water spray cooling system required by the original units. The redesigned APUs are expected to extend the life of the units from the current 20 hours or 12 flights to 75 hours or 50 flights. The increased lifetime is anticipated to result in fewer APU changeouts and improved ground turnaround time between flights.

Components of the APU that have been redesigned to improve reliability include gas generator, fuel pump, redundant seals between the fuel system and gearbox lubricating oil and a materials change in the turbine housings.

## **Orbiter Drag Chute**

During construction, a drag chute was added to Endeavour to be deployed between main gear and nose gear touchdown to assist in stopping and add greater stability in the event of a flat tire or steering problem. The drag chute is another in a series of improvements to the Shuttle's landing aids. Other improvements recently installed in Shuttle orbiters and already in use include carbon brakes to replace the original beryllium brakes and nose wheel steering mechanisms.

The 40-foot diameter drag chute canopy will trail 87 feet behind the orbiter as it rolls out after landing. The main drag chute and a 9-foot diameter pilot chute are deployed by a mortar fired from a small compartment added to the bottom of the vertical stabilizer. The drag chute will be jettisoned when the spacecraft slows to less than 60 knots.

The drag chute is expected to decrease the orbiter's rollout distance by 1,000 to 2,000 feet. The drag chute is deployed using two switches located to the left of the commander's heads up display. One switch arms the mortar and a second switch fires it. A third switch, located to the right of the commander's heads up display, jettisons the drag chute. A second set of switches is mounted beside the pilot's heads up display.

From the time the pilot chute mortar is fired to full inflation of the main chute is anticipated to be less than 5 seconds. The drag chute system was designed by NASA's Johnson Space Center, Rockwell-Downey and Irvin Industries, Santa Ana, Calif.

## **EXTENDED DURATION ORBITER MODIFICATIONS**

Although there are no plans currently to use it as such, Endeavour has been fitted with internal plumbing and electrical connections needed for a series of Extended Duration Orbiter (EDO) modifications that could enable the spacecraft to stay in orbit as long as 28 days. The first extended duration flight is currently planned for June 1992, the USML-1 flight aboard Columbia (modified between August 1991 and February 1992) is planned to be 13 days long.

Modifications necessary for extended stays include an improved waste collection system that compacts human waste, thus allowing greater capacity; extra middeck lockers for additional stowage; two additional nitrogen tanks for the crew cabin atmosphere; a regenerating system for removing carbon dioxide from the crew cabin atmosphere; and a set of supercold liquid hydrogen and liquid oxygen tanks mounted on a special pallet in the payload bay as supplemental fuel for the Shuttle's electrical generation system.

Modifications already made to Endeavour include:

### **Additional Nitrogen Tanks**

The internal electrical and plumbing connections have been built into Endeavour to allow for nitrogen tank installation. At present, there is no timetable for installation of these tanks. If installed, they would be located near the current nitrogen tanks below the payload bay.

### **Additional Cryogenic Tanks**

Endeavour has five liquid hydrogen and five liquid oxygen tanks installed internally. On the rest of the orbiter fleet, Columbia also has five tank pairs, and Atlantis and Discovery each have four tank sets. In addition, Endeavour has the internal connections needed to hook up an Extended Duration Orbiter cryogenic payload bay pallet, containing four additional tanks of both hydrogen and oxygen. The plumbing systems on board Endeavour could be hooked up to feed fuel from such a pallet to create electricity and water for the Shuttle. The four payload bay tank sets coupled with five internal sets provide a 16-day mission capability. For a 28-day mission, four additional tank sets would be required in the payload bay on either a second pallet or larger pallet.

### **Improved Waste Collection System**

Hookups for an Improved Waste Collection System are built into Endeavour. The IWCS compacts human waste and has an increased capacity for storage of waste.

### **Regenerative Carbon Dioxide Removal System**

Endeavour is outfitted with a Regenerative Carbon Dioxide Removal System that may be used in tandem with Lithium Hydroxide (LioH) canisters to remove carbon dioxide from the crew cabin atmosphere. The regenerative system, if used alone, would eliminate the need to carry extensive amounts of LioH canisters for a long flight. Currently, the crew must change out LioH canisters daily as part of spacecraft housekeeping.

The regenerative system works by removing the CO<sub>2</sub> and then releasing it to space through a vent. The new system will not be used alone for Endeavour's first flight, but will be tested. Enough LioH canisters for the first flight will be flown aboard Endeavour to allow proven equipment to be used for the duration. The regenerative system is located under the middeck floor.

## **Additional Cabin Stowage**

Endeavour is outfitted with brackets necessary to mount additional middeck lockers on board. About 127 cubic feet of additional stowage would be needed for an extended duration flight. The crew compartment size, however, is exactly the same as all other orbiters.

## **NAMING OF OV-105 AS SPACE SHUTTLE ENDEAVOUR**

In response to the outpouring of concerns by students after the Challenger accident, Congressman Tom Lewis (R-Fla.) introduced a bill in Congress to establish the NASA Orbiter-Naming Program. In October 1987, Congress authorized that the name for Orbiter Vehicle 105 be selected "from among suggestions submitted by students in elementary and secondary schools."

The name "Endeavour" resulted from a nationwide orbiter-naming competition supported by educational projects created by student teams in elementary and secondary schools. NASA's orbiters are named after sea vessels used in research and exploration. Therefore, the teams education project had to relate to exploration, discovery and experimentation.

The NASA Orbiter-Naming Program involved over 71,000 students with over 6,100 entries. In May 1989, President Bush selected and announced the winning name and met with the national winning teams of both divisions.

The winning team in Division I (K-6) was the fifth grade class from Senatobia Middle School, Senatobia, Miss. The winning team in Division II (7-12) was from the Tallulah Falls School, Inc., Tallulah Falls, Ga. Both winning teams proposed the name "Endeavour," the first ship commanded by Captain James Cook, a British explorer, navigator and astronomer. In August 1768, on Endeavour's maiden voyage, Cook observed and recorded the transit of the planet Venus.

President Bush said the teams "showed how the possibilities of tomorrow point us onward and upward. Both of your schools chose the name 'Endeavour' which Webster's defines as 'to make an effort, strive, to try to reach or achieve.' And each of your schools has lived that definition."

## STS-49 CREW BIOGRAPHIES

**Daniel C. Brandenstein**, 49, Capt., USN, is the Commander of STS-49. Selected as an astronaut in January 1978, Brandenstein was born in Watertown, Wis., and will be making his fourth space flight.

He was the Pilot on STS-8, the first Shuttle mission with a night launch and night landing. On his second mission, Brandenstein commanded the crew of STS-51G, deploying four satellites and retrieving one. In 1990, he commanded STS-32 which retrieved the 21,400 pound Long Duration Exposure Facility.

Brandenstein graduated from Watertown High School and received a bachelor of science in mathematics and physics from the University of Wisconsin in 1965.

He was designated a naval aviator in 1967 and served in a variety of operational and flight test billets. He has logged 6,300 hours flying time in 24 different types of aircraft, including 400 aircraft carrier landings. With the completion of his third space flight, Brandenstein has logged 576 hours in space.

**Kevin P. Chilton**, 36, Lt. Col., USAF, will serve as Pilot. Selected as an astronaut in June 1987, Chilton was born in Los Angeles, Calif., and will be making his first space flight.

Chilton graduated from St. Bernard High School, Playa del Rey, Calif., in 1972; received a bachelor of science in engineering sciences from the Air Force Academy in 1976; and received a master of science in mechanical engineering from Columbia University on a Guggenheim Fellowship in 1977.

He served as a combat ready pilot and instructor pilot in the RF-4 and F-15 from 1978 to 1983. In 1984, he graduated from the Air Force Test Pilot School and served as a test pilot until his selection as an astronaut in 1987.

**Richard J. Hieb**, 36, will serve as Mission Specialist 1 (MS1) and Extravehicular Activity crewman 2 (EV2). Born in Jamestown, N.D., Hieb was selected as an astronaut in 1985 and will be making his second space flight.

He flew as a mission specialist on STS-39, operating the Shuttle's remote manipulator system to deploy and retrieve the SPAS satellite.

Hieb graduated from Jamestown High School in 1973; received a bachelor of arts in math and physics from Northwest Nazarene College in 1977 and received a master of science in aerospace engineering from the University of Colorado in 1979. After graduation, Hieb joined NASA to work in crew procedures development and crew activity planning. He worked in the Mission Control Center on the ascent team for STS-1 and during rendezvous phases on numerous subsequent flights.

He has logged 199 hours in space.

**Bruce E. Melnick**, 42, Cmdr., USCG, will serve as Mission Specialist 2 (MS2). Selected as an astronaut in June 1987, Melnick was born in New York, N.Y., but considers Clearwater, Fla., to be his hometown and will be making his second space flight.

Melnick graduated from Clearwater High School, attended Georgia Tech, received a bachelor of science in engineering from the Coast Guard Academy in 1972 and received a master of science in aeronautical systems from the University of West Florida in 1975.

Melnick served as a mission specialist on STS-41, which deployed the Ulysses spacecraft. He has logged more than 4,900 hours aircraft flying time, predominantly in the H-3, H-52, H-65 and T-38 aircraft. Melnick has logged 98 hours in space.

**Pierre J. Thuot**, 36, Cmdr., USN, will serve as Mission Specialist 3 (MS3) and Extravehicular Activity crewman 1 (EV1). Selected as an astronaut in June 1985, Thuot was born in Groton, Conn., but considers Fairfax, Va., and New Bedford, Mass., to be his hometowns and will be making his second space flight.

Thuot graduated from Fairfax High School, received a bachelor of science in physics from the Naval Academy in 1977 and received a master of science in systems management from the University of Southern California in 1985.

Thuot served as a mission specialist on STS-36, a Department of Defense-dedicated mission. He has more than 2,700 flight hours in more than 40 different aircraft, including 270 carrier landings. He has logged 106 hours in space.

**Kathryn C. Thornton**, 39, will serve as Mission Specialist 4 (MS4) and Extravehicular Activity crewman 3 (EV3). Selected as an astronaut in May 1984, Thornton was born in Montgomery, Ala., and will be making her second space flight.

She received a bachelor of science in physics from Auburn University, a master of science in physics from the University of Virginia in 1977 and received a doctorate of philosophy in physics from the University of Virginia in 1979. Thornton was awarded a NATO postdoctoral fellowship to continue her research at the Max Planck Institute of Nuclear Physics in Heidelberg, Germany. Prior to being selected by NASA, she was a physicist at the U.S. Army Foreign Science and Technology Center in Charlottesville, Va.

Thornton was a mission specialist on STS-33, a Department of Defense-dedicated flight. She has logged 120 hours in space.

**Thomas D. Akers**, 40, Lt. Col., USAF, will serve as Mission Specialist 5 (MS5) and Extravehicular Activity crewman 4 (EV4). Selected as an astronaut in June 1987, Akers was born in St. Louis, Mo., but considers Eminence, Mo., his hometown and will be making his second space flight.

He graduated from Eminence High School and received bachelor and master of science degrees in applied mathematics from the University of Missouri-Rolla in 1973 and 1975, respectively.

Akers was a National Park Ranger and spent 4 years as the high school principal in his hometown of Eminence before joining the Air Force in 1979. He served at Eglin Air Force Base, Fla., and Edwards Air Force Base, Calif., as a flight test engineer in F-4 and T-38 aircraft.

He flew as a mission specialist on STS-41, deploying the Ulysses spacecraft. Akers has logged 98 hours in space.

## **SHUTTLE MISSION STS-49 MANAGEMENT**

### **NASA HEADQUARTERS, WASHINGTON, D.C.**

#### **Office of Space Flight**

Thomas E. Utsman -	Deputy Associate Administrator
Leonard Nicholson -	Director, Space Shuttle

#### **Office of Commercial Programs**

John G. Mannix -	Assistant Administrator for Commercial Programs
Richard H. Ott -	Director, Commercial Development Division
Garland C. Misener -	Chief, Flight Requirements and Accommodations
Ana M. Villamil -	Program Manager, Centers for the Commercial Development of Space

#### **Office of Safety & Mission Quality**

George A. Rodney -	Associate Administrator
Charles Mertz -	Deputy Associate Administrator (Acting)
Richard U. Perry -	Director, Programs Assurance Division

**KENNEDY SPACE CENTER, FLA**

Robert L. Crippen -	Director
James A. "Gene" Thomas -	Deputy Director
Jay Honeycutt -	Director, Shuttle Management and Operations
Robert B. Sieck -	Launch Director
John J. "Tip" Talone -	Endeavour Flow Director
J. Robert Lang -	Director, Vehicle Engineering
Al J. Parrish -	Director of Safety Reliability and Quality Assurance
John T. Conway -	Director, Payload Management and Operations
P. Thomas Breakfield -	Director, Shuttle Payload Operations
Joanne H. Morgan -	Director, Payload Project Management
Roelof L. Schuiling -	STS-49 Payload Processing Manager

**MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, AL**

Thomas J. Lee -	Director
Dr. J. Wayne Littles -	Deputy Director
Alex A. McCool -	Manager, Shuttle Projects Office
Dr. George F. McDonough -	Director, Science and Engineering
James H. Ehl -	Director, Safety and Mission Assurance
Alex A. McCool -	Acting Manager, Space Shuttle Main Engine Project
Victor Keith Henson -	Manager, Solid Rocket Motor Project
Cary H. Rutland -	Manager, Solid Rocket Booster Project
Gerald C. Ladner -	Manager, External Tank Project

**JOHNSON SPACE CENTER, HOUSTON, TX**

Paul J. Weitz -	Director (Acting)
Paul J. Weitz -	Deputy Director
Daniel Germany -	Manager, Orbiter and GFE Projects
Donald R. Puddy -	Director, Flight Crew Operations
Eugene F. Kranz -	Director, Mission Operations
Henry O. Pohl -	Director, Engineering
Charles S. Harlan -	Director, Safety, Reliability and Quality Assurance

**STENNIS SPACE CENTER, BAY ST. LOUIS, MS**

Gerald W. Smith -	Director (Acting)
J. Harry Guin -	Director, Propulsion Test Operations

**AMES-DRYDEN FLIGHT RESEARCH FACILITY, EDWARDS, CA**

Kenneth J. Szalai -	Director
T. G. Ayers -	Deputy Director
James R. Phelps -	Chief, Space Support Office

# SHUTTLE FLIGHTS AS OF APRIL 1992

46 TOTAL FLIGHTS OF THE  
SHUTTLE SYSTEM - 21 MISSION  
CONDUCTED SINCE RETURN TO  
FLIGHT.

14				
13				
12				
11				
10				
09				
08				
07				
06				
05				
04				
03				
02				
01				
	STS 51-L 01/28/86	STS-40 06/05/91 - 06/14/91	STS-42 01/22/92 - 01/30/92	STS-45 03/24/92 - 04/02/92
	STS 61-A 10/30/85 - 11/06/85	STS-35 12/02/90 - 12/10/90	STS-48 09/12/91 - 09/18/91	STS-44 11/24/91 - 12/01/91
	STS 51-F 07/29/85 - 08/06/85	STS-32 01/09/90 - 01/20/90	STS-39 04/28/91 - 05/06/91	STS-43 08/02/91 - 08/11/91
	STS 51-B 04/29/85 - 05/6/85	STS-28 08/08/89 - 08/13/89	STS-41 10/06/90 - 10/10/90	STS-37 04/05/91 - 04/11/91
	STS 41-G 10/5/84 - 10/13/84	STS 61-C 01/12/86 - 01/18/86	STS-31 04/24/90 - 04/29/90	STS-38 11/15/90 - 11/20/90
	STS 41-C 04/06/84 - 04/13/84	STS-9 11/28/83 - 12/08/83	STS-33 11/22/89 - 11/27/89	STS-36 02/28/90 - 03/04/90
	STS 41-B 02/03/84 - 02/11/84	STS-5 11/11/82 - 11/16/82	STS-29 03/13/89 - 03/18/89	STS-34 10/18/89 - 10/23/89
	STS-8 08/30/83 - 09/05/83	STS-4 06/27/82 - 07/04/82	STS-26 09/29/88 - 10/03/88	STS-30 05/04/89 - 05/08/89
	STS-7 06/18/83 - 06/24/83	STS-3 03/22/82 - 03/30/82	STS 51-I 08/27/85 - 09/03/85	STS-27 12/02/88 - 12/06/88
	STS-6 04/04/83 - 04/09/83	STS-2 11/12/81 - 11/14/81	51-G 06/17/85 - 06/24/85	STS 61-B 11/26/85 - 12/03/85
		STS-1 04/12/81 - 04/14/81	51-D 04/12/85 - 04/19/85	STS 51-J 10/03/85 - 10/07/85
			STS 51-C 01/24/85 - 01/27/85	
			STS 61-A 11/07/84 - 11/15/84	
			STS 41-D 08/30/84 - 09/04/84	

OV-099  
CHALLENGER

OV-102  
COLUMBIA

OV-103  
DISCOVERY

OV-104  
ATLANTIS

OV-105  
ENDEAVOUR

First flight scheduled  
for May 1992

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400



Terri Sindelar  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

For Release  
April 17, 1992

RELEASE: 92-49

## ATTACK OF THE KILLER SPACE TOMATOES? NOT!

Space tomatoes have been popping up all over the world. In fact, more than 3.3 million budding student scientists and 64,000 teachers in all 50 states, the District of Columbia and 34 foreign countries have grown and compared space-exposed tomatoes with earth-based tomatoes. The students have completed their investigations and NASA has analyzed and compiled their findings. The results indicate that the space tomatoes were as healthy as their Earth-based siblings and were "tastier, juicier and sweeter!" NASA now knows that seeds can survive in space for long periods of time with little or no change in the resulting plant.

The Space Exposed Experiment Developed for Students (SEEDS) is a national science project that brought students into the scientific community to experience the excitement, interaction, hope and disappointment that is the nature of science.

The national science experiment involved flying over 12.5 million tomato seeds in space for nearly 6 years. SEEDS was one of 57 experiments housed onboard the Long Duration Exposure Facility (LDEF) satellite launched by the crew of Challenger in April 1984 and retrieved by the crew of Columbia on Jan. 12, 1990.

Experimental observations were compiled by students in elementary through graduate school. Of the 8,000 reports returned to NASA, the findings suggest that the space-exposed seeds germinated slightly faster. In addition, the space-exposed seedlings had a faster initial growth rate, observed for the first 3 or 4 weeks of growth. Eventually, the Earth-based seedlings caught up with their counterparts and overall, no differences were found between the two types of plants or their fruits.

Many SEEDS participants did not return the data collection forms or returned partially completed forms or forms with reporting errors. Any shortcomings in data reporting should not overshadow the primary value of SEEDS: Students from all over the world contributed data and learned about science from an experimenters viewpoint.

- more -

In addition to the basic experiment, some student researchers used the SEEDS project to begin long-term research on such topics as space seed histology, chromosome morphology, and cell cycle time of the space-exposed plants and their descendents. Other student investigators are conducting third generation studies.

Three student-designed experiments discovered that the space-exposed plants had greater levels of chlorophyll and carotenes than the Earth-based plants. In addition, tests found that light absorbance was greater in extracts made from space-exposed plant tissues. Finally, results from laser-induced fluorescent spectroscopy concluded that space-exposed seeds exhibited premature chlorophyll development.

SEEDS was designed to be quality, hands-on science. Students experienced the successes, failures, puzzles and solutions inherent in scientific problem solving. SEEDS had all these rewards and hazards, especially to the plants.

A child in Ontario wrote: "Dear NASA: Hi, My name is Matt. I am in grade 2. I really enjoy growing my plants. Here are my results. My Earth seed did not grow. My space seed grew but it fell off my desk. It died."

Those plants fortunate enough to survive the rigors of the classroom were transported to the outside world to begin their new life in a garden. However, unpredicted hardships and natural disasters began to fall on these plants' newly-found freedom. Hailstorms hit certain areas, as did late freezes, high heat and thunderstorms. Some seedlings became prey for mice, moles and worms.

Other space plants suffered from "people disasters." A parent in Portland, Oregon wrote that his stepson found his space plants were not even safe from his 4-year-old stepsister's "Michael Jordan 3-point shot" when it rebounded and severely damaged both of his space-exposed plants. Miraculously, the plants survived and later produced a tomato that won the Youth Division Vegetable Oddity Blue Ribbon at the Oregon State University Extension Seed Harvest Fair.

As for the fruit, researchers were quick to reveal the tantalizing effects on their tastebuds. Some reported the fruit as "tastier, juicier, and sweeter." Others claimed the tomatoes had thicker skins and more seeds. Others simply said, "Made enough Gazpacho for a week."

Tests of fruit pH found no difference between space-exposed and Earth-based plants. Space-exposed plants also performed normally in tests of geotropism, tissue culturing, seed weight and phototropism.

Interesting observations reported include differences in plant size, leaf shape and size, stem and leaf color, root size, stem thickness, and resistance to heat, cold, draught and pests. Even though many student researchers were disappointed not to see drastically altered mutant plants and fruit, it is now known that seeds can survive in space for long periods of time with little or no change in the resulting plant.

One of the most interesting occurrences resulting from the experiment came from the media attention surrounding the possibility of radiation-induced mutations in the space-exposed tomatoes. A Los Angeles Times article warning of a possibility of poisonous fruit from the space-exposed plants appeared shortly after the seeds were distributed. The article was based on the science that radiation can affect the DNA of the seed resulting in lethal alterations. In the space-exposed seeds, such somatic mutations would cause a point mutation, altering the DNA molecule at a single base pair. Such a change would only affect the resulting plant, most likely being lethal to the plant itself, and would not be passed on to the plant's descendants.

It is more likely that such a mutation would occur in normal Earth-based tomatoes, given the number of tomato plants grown worldwide and the cumulative amount of radiation and other mutagens these plants are exposed to each growing season. Radiation emission occurs naturally in the environment from soil, building materials, rocks, ground water, food and even our own bodies. But as explained in the SEEDS Teacher's Guide, the effects of long-term radiation exposure was one of the chief variables of the experiment.

Nevertheless, the articles added a new realm to the experiment that would have been missed had the article not been published. In most cases, teachers saw the attention as a good way to stimulate thinking and discussion about the experiment, teach concepts of radiation and radioactivity and develop an understanding of genetics and mutations. An elementary teacher in San Antonio wrote, "... the experiment and the media flap produced much discussion about radiation, mutation and the like. We feel the experience was very beneficial to the students." Many teachers reported they enjoyed eating the space-exposed fruit. One teacher planned to make tomato jam as Christmas presents.

Ken Selee, a teacher in Turlock, Calif., represents so many creative teachers in the country and exemplifies the ways the "Space Tomatoes" were embraced by the world. He saw SEEDS as a way to excite students about the space program and teach good science. He organized seeds distribution throughout Turlock public schools, kept schools updated through a newsletter, developed social events to inform the public of his student's success and involved more than 500 people in SEEDS. Knowing the good weather conditions of California, Selee raced the nation in producing the first ripe space tomato. To celebrate, his classes organized the first Bacon, Lettuce and Space Tomato Sandwich Party.

SEEDS exposed future scientists of the nation to an experiment that tests the effects of long-term space exposure on seeds and set the stage for one of this country's largest science learning projects. States one parent from Boston, "Our children were eager NASA scientists, fascinated with the concept of space tomatoes, and rewarded not only by their satisfaction coming from the completion of an independent scientific search, but also by the realization of working on a national project with unknown results. You have provided the children with a special and well designed experience which they'll always remember."

Many teachers also wrote warm and encouraging words to NASA. An elementary teacher in Port Orchard, Wash., wrote, "Thank you for giving America's schoolchildren an opportunity to really be a part of the space program. I am thrilled with the level of interest today's youth have for anything that has to do with space."

An elementary teacher in Brockpoint, N.Y., responded, "The part that excited my students the most was a sense of pride in knowing they were doing the same thing as students in all parts of the country. It provided great opportunities and similarities in lots of different areas, and still feel a sense of real unity as Americans."

Written by an elementary school teacher in Robbinsdale, Minn., "The project was indeed exciting for all of us -- seeds from space! Do it again! Science is alive and well for my 6th graders. They felt a part of a 'real world' project. Thanks!"

NASA Administrator Daniel S. Goldin responded, "To the elementary school teacher in Robbinsdale, Minn., and to all students, teachers, parents and communities who participated in SEEDS, we at NASA also found the project to be exciting, informative and rewarding. When government, industry and education team together, we can bring the students of America a great national science project. Many thanks to our cooperative partner, the George W. Park Seed Company. NASA plans to continue offering national science projects to stimulate interest in science through active involvement.

"We sincerely hope the learning from SEEDS will continue for many years to come . . . for someday these budding scientists will be the experimenters and explorers on Space Station Freedom and at the lunar outpost, and they will be the first Martians."

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400



Terri Sindelar  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

For Release  
April 20, 1992

RELEASE: 92-50

## NASA AWARDS EDUCATION RESEARCH GRANTS

NASA today awarded research grants to three universities to develop teacher training courses that will enable middle school teachers to incorporate aerospace topics and concepts into their classrooms and to create new and imaginative practices in learning.

The Teacher Training Pre-Service Program is a 2-year program. The following schools were selected from responses to a solicitation of proposals: Fayetteville State University, Fayetteville, N.C.; Eastern Michigan University, Ypsilanti; and the University of Alabama, Tuscaloosa. Each will receive a \$83,000 grant and are expected to provide matching, non-Federal funds.

The institutions will create teacher training programs that integrate aerospace concepts into middle school subjects, including math, science, arts, language, history and social studies. By better preparing graduating teachers with these skills, tools and knowledge, it is hoped that the program will help stimulate student interest and learning, foster science literacy and encourage better performance in math and science.

All proposers agreed to an innovative requirement for the pilot program, a "proof of concept" approach that the product 1) be offered as a catalog-listed course for undergraduate teacher education credit, 2) be adapted and used in an accredited summer workshop for experienced teachers, and 3) be offered, with guidance, for national replication.

Fayetteville State University has developed a project to create a pre-service, hands-on integrated science and math program. The program will provide middle school teachers with direct experiences of scientific investigators.

- more -

Eastern Michigan University's project will focus on technology and space education to integrate existing middle school curriculum to promote learning and to develop problem-solving and creative and critical thinking skills. All project activities will build upon existing NASA projects, especially those for upper-elementary school. The Environmental Research Institute of Michigan is cooperating on this project.

The University of Alabama will develop two interdisciplinary aerospace science courses for both the non-science education major and non-science teacher.

In 1990, NASA awarded two research grants to develop aerospace-related training courses for elementary-level student teachers and incorporate aerospace topics into new or existing credit courses.

- end -



Paula Cleggett-Haleim  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

For Release

April 23, 1992  
12:00 p.m., EDT

Randee Exler  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-7277)

RELEASE: 92-51

## COBE DETECTS STRUCTURE OF EARLY UNIVERSE

Scientists announced today, at the American Physical Society's meeting held in Washington, D.C., that they have detected the long-sought variations within the glow from the Big Bang -- the primeval explosion that began the Universe 15 billion years ago -- using NASA's Cosmic Background Explorer (COBE). This detection is a major milestone in a 25-year search and supports theories explaining how the initial expansion happened.

These variations show up as temperature fluctuations in the sky, revealed by statistical analysis of maps made by the Differential Microwave Radiometers (DMR) on the COBE satellite. The fluctuations are extremely faint, only about thirty millionths of a degree warmer or cooler than the rest of the sky, which is itself very cold -- only 2.73 degrees above absolute zero. The DMR is still gathering data and the measurements are expected to become even more precise.

The Big Bang theory was initially suggested because it explains why distant galaxies are receding from us at enormous speeds, as though all galaxies started moving away from the same location a long time ago. The theory also predicts the existence of cosmic background radiation -- the glow left over from the explosion itself. The Big Bang theory received its strongest confirmation when this radiation was discovered in 1964 by Arno Penzias and Robert Wilson, who later won the Nobel Prize for this discovery.

Although the Big Bang theory is widely accepted, there have been several unresolved mysteries. How could all of the matter and energy in the Universe become so evenly mixed in the instant following the Big Bang? How could this evenly distributed matter then break up spontaneously into objects of all sizes, such as galaxies and clusters of galaxies? The temperature variations seen by COBE help to resolve these mysteries.

"The COBE receivers mapped the sky as it would appear if our eyes could see microwaves at the wavelengths 3.3, 5.7 and 9.6 mm, which is about 10,000 times longer than the wavelength of ordinary light," explained Dr. George Smoot, University of California, Berkeley, the leader of the team that made this discovery. "Most of the energy received from the sky at these wavelengths is from the cosmic background radiation of the Big Bang, but it is extremely faint by human standards.

"Hundreds of millions of measurements were made by the DMR over the course of a year, and then combined to make pictures of the sky. Making sure all the measurements were combined correctly required exquisitely careful computer analysis," Smoot explained.

Another COBE scientist, Dr. Charles Bennett of the Goddard Space Flight Center, Greenbelt, Md., explained that a major challenge for the team was to distinguish the Big Bang signals from those coming from our own Milky Way Galaxy. "The Milky Way emits microwaves that appear mostly concentrated in a narrow zone around the sky. We compared the signals at different positions and at different wavelengths to separate the radiation of the Big Bang from that of the Milky Way Galaxy," said Dr. Bennett.

The temperatures and sizes of the fluctuations in the background radiation COBE detected agree with the predictions of "inflationary cosmology," a theory that says the structure and behavior of the Universe were determined by minute fluctuations occurring when the Universe was much younger than one-trillionth of a second. The COBE results provide new evidence in support of the "inflationary" scenario.

The amount of gravity provided by these visible fluctuations was inadequate to draw together the galaxies and clusters of galaxies. Instead, astronomers conclude that the galaxies formed only because most of the material in the Universe is invisible and totally unlike ordinary matter.

This "dark matter" provides the necessary gravitational attraction for forming galaxies. The fluctuations seen by COBE are too small to explain how the visible matter in the young Universe could condense into the galaxies that now exist. According to COBE scientist Dr. Edward Wright from the University of California, Los Angeles, the COBE measurements support theories postulating large amounts of dark matter.

"These theories say that most of the matter in the Universe is invisible to us and must be a new kind of matter, not yet detected in our laboratories," he explained. "Nevertheless, we need such invisible matter to explain how galaxies formed in the early Universe and gathered themselves together into huge clusters. Ordinary matter would be attracted into regions of concentrated dark matter, and the Universe as we know it today could develop, eventually leading to the formation of galaxies, stars and planets," Wright said.

COBE was launched in November, 1989, from Vandenberg Air Force Base, Calif., aboard a Goddard-managed Delta launch vehicle. The Goddard Space Flight Center, Greenbelt, Md., manages COBE for NASA's Office of Space Science and Applications, Astrophysics Division, Washington, D.C.

- end -

Drucella Andersen  
Headquarters, Washington, D.C.  
(Phone: 202/453-8613)

For Release  
April 24, 1992

Don Haley  
Ames-Dryden Flight Research Facility, Edwards, Calif.  
(Phone: 805/258-3456)

RELEASE: 92-52

## **X-31 DEMONSTRATOR FLIGHTS RESUMED AT AMES-DRYDEN**

Flights of the X-31 Enhanced Fighter Maneuverability demonstrator aircraft resumed yesterday afternoon at NASA's Ames-Dryden Flight Research Facility, Edwards, Calif.

Today's mission, piloted by Carl Lang of the German firm Messerschmitt-Bolkow-Blohm, lasted about 1 hour. It was a check of aircraft systems after a period of planned maintenance. The X-31s are being flown at Ames-Dryden to show the value of thrust vectoring (directing engine exhaust flow) coupled with an advanced flight control system for close-in air combat at very high angles-of-attack.

An international test organization, managed by the Defense Advanced Research Projects Agency (DARPA), is conducting the flight tests to obtain data that may apply to highly-maneuverable next-generation fighters.

During the next year, an international team of pilots will make as many as 20 test flights a month with each X-31. They will expand the plane's flight envelop at Ames-Dryden to prepare for military utility evaluations at the Naval Air Test Center, Patuxent River, Md., in early 1993.

The two aircraft made 108 test flights in the program's initial phase of operations at Rockwell International's Palmdale, California's facility before resuming operations at Ames-Dryden. The X-31 first flew in October 1990.

-more-

"Angle-of-attack" is an engineering term for the angle of an aircraft's body and wings relative to its actual flight path. In combat maneuvers, pilots often fly at extreme nose-high angles while the plane continues to go forward. At high angles-of-attack, forces produced by the aerodynamic surfaces are reduced and the pilot can lose control of the aircraft.

Thrust vectoring paddles on the X-31's exhaust nozzle direct the exhaust flow to provide control in pitch (up and down) and yaw (right and left) that improves maneuverability at high angles-of-attack. Military officials believe that this can give fighter pilots a tactical advantage over planes without enhanced controls.

Besides DARPA and NASA, the X-31 International Test Organization (ITO) includes the U.S. Navy, the U.S. Air Force, Rockwell International, the Federal Republic of Germany and Messerschmitt-Bolkow-Blohm. About 110 people from the ITO agencies are assigned to the program. NASA is responsible for flight test operations and will take part in aircraft maintenance and research engineering.

The X-31 is the first international experimental aircraft development program administered by a U.S. government agency. It is a key effort of the NATO Cooperative Research and Development Program.

-end-

NOTE TO EDITORS: Photographs are available to media representatives to illustrate this release by calling 202/453-8375.

Color: 92-HC-249  
92-HC-250

B&W: 92-H-285  
B&W: 92-H-286

Posted: Mon, Apr 27, 1992 4:13 PM EDT      Msg: CJJC-3009-6331  
From: HQNEWSROOM  
To: P, PAOLOP.NASAMAIL,  
(C:USA,ADMD:TELEMAIL,PRMD:GSFC,O:GSFCMAIL,UN:PUBINFO),  
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(C:USA,ADMD:TELEMAIL,O:SPACEMAIL,UN:NASA.BB)  
Subj: N92-32/ADMINISTRATOR GOLDIN TO ADDRESS AIAA

David W. Garrett  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

April 27, 1992

N92-32  
NOTE TO EDITORS

GOLDIN TO ADDRESS AIAA GROUP AND MEET THE PRESS

NASA Administrator Daniel S. Goldin will address members of the American Institute of Aeronautics and Astronautics on April 28 at 9:00 a.m. EDT and will hold a press conference at 10:00 a.m. EDT. Both events take place at the Crystal City Hyatt Regency Hotel, Arlington, Va. The press conference location is the Potomac Room (1 and 2).

Live NASA Select television will not be available, however, the address and press conference will be taped and played at 12:00 noon EDT. NASA Select television is carried on SATCOM F2R, transponder 13, located at 72 degrees west.

-end-

Posted: Mon, Apr 27, 1992 4:13 PM EDT      Msg: BJJC-3009-6330  
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Subj: HQ STS-49 LAUNCH ADVISORY

FOR IMMEDIATE

Mark Hess/Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/453-8536)

April 27, 1992

STS-49 SPACE SHUTTLE LAUNCH ADVISORY

NASA today rescheduled the maiden flight of the Space Shuttle Endeavour to May 7. The launch window for that date extends from 7:06 to 7:55 p.m. EDT.

"We reviewed the criteria for the first flight of Endeavour and determined it would be prudent to delay the date from May 4 so that we could obtain the normal photographic documentation that a daylight launch affords," said NASA's Acting Associate Administrator for Space Flight Tom Utsman.

- end -

For Release

Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

April 27, 1992

Dane Konop  
National Oceanic and Atmospheric Administration, Silver Spring, Md.  
(Phone: 301/713-2465)

NOTE TO EDITORS: N92-33

## **NASA, NOAA TO HOLD PRESS CONFERENCE ON OZONE DEPLETION**

Scientists from NASA and NOAA programs studying ozone depletion over the Northern Hemisphere this winter will present their preliminary findings at a press conference on April 30.

The press conference will be held at 1 p.m. EDT in the NASA Headquarters auditorium, 6th floor, 400 Maryland Ave., S.W., Washington, D.C. The panel's moderator will be Dr. Robert Watson, Director of NASA's Process Studies Program Office, Earth Science and Applications Division, NASA Headquarters, Washington, D.C. The panel will include Dr. Joe Waters, Upper Atmosphere Research Satellite (UARS) investigator, of the Jet Propulsion Laboratory, Pasadena, Calif.; Dr. Michael Kurylo, Program Scientist for the NASA-NOAA Airborne Arctic Stratospheric Expedition (AASE II), NASA Headquarters; Dr. James Anderson, AASE II Project Scientist, Harvard University, Cambridge, Mass.; Dr. David Fahey, AASE II Investigator, NOAA Aeronomy Laboratory, Boulder, Colo.; Dr. Brian Toon, AASE II DC-8 Flight Scientist, Ames Research Center, Mountain View, Calif.; and Dr. Mark Schoeberl, Head of the Atmospheric Chemistry and Dynamics Branch, Goddard Space Flight Center, Greenbelt, Md.

The AASE II team has completed 6 months of airborne measurements of ozone-related chemistry operating from bases in Bangor, Maine, and Fairbanks, Alaska. UARS, launched in September 1991, is making global studies of the chemistry, dynamics and energetics of ozone depletion in the upper atmosphere.

The press conference will be carried live on NASA Select Television, Satcom F-2R, transponder 13, 72 degrees west longitude, frequency 3960.0 MHz, audio 6.8 MHz. Questions will be taken from other NASA centers.

Images from AASE II, UARS and Total Ozone Mapping Spectrometer will be available from NASA Headquarters Audio-Visual Branch by calling 202/453-8375.

- end -

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400

Sue Richard  
Headquarters, Washington, D.C.  
(Phone: 202/453-8364)

For Release  
April 28, 1992

RELEASE: 92-54

## **NASA ADMINISTRATOR ANNOUNCES HEADQUARTERS APPOINTMENTS**

NASA Administrator Daniel S. Goldin announced today the appointment of 6 people to senior management positions at NASA Headquarters in Washington, D.C. He made the announcement at the annual meeting of the American Institute of Aeronautics and Astronautics in Arlington, Va.

Goldin appointed Major General Jeremiah W. Pearson III, USMC, as Associate Administrator, Office of Space Flight, to replace William B. Lenoir who announced plans to leave the agency May 4. In this position, he will be responsible for overall management of the Space Shuttle program, Spacelab operations and planning for Space Station Operations. Pearson is now Assistant Deputy Chief of Staff for Plans, Policies and Operations/Director, Plans Division, Plans, Policies and Operations Dept. at Marine Corps Headquarters, Washington, D.C. Prior to that he was Deputy Commander of Marine Forces, Central Command during Operation Desert Shield/Storm in Riyadh, Saudi Arabia. He has a Bachelor of Science in Aeronautical Engineering from Georgia Institute of Technology and a Master of Science in Systems Engineering from the University of Southern California.

Bryan D. O'Connor, a former NASA Astronaut and Colonel, USMC, was named as Deputy Associate Administrator, Office of Space Flight for Programs. In this position, he will be responsible for the review of all Office of Space Flight programs to insure realistic planning and execution. In particular, he will be concerned with Space Shuttle activities and the overall Total Quality Management activities being accomplished across the board. O'Connor is a 1968 Naval Academy graduate and received a Master of Science in Aeronautical Systems from the University of West Florida. A veteran of two space missions, he has logged over 383 hours in space, as Pilot on STS-61B in 1985 and as Commander of STS-40, June, 1991.

- more -

Goldin named Charles F. Bolden, NASA Astronaut and Colonel, USMC, to the new position of Assistant Deputy Administrator. In this position he will be responsible for integrating and ensuring the effective accomplishment of the Total Quality Management review activities being initiated across the agency. Bolden, a 1968 Naval Academy graduate, received a Master of Science in Systems Engineering from the University of Southern California in 1977. A veteran of three space missions, Bolden served as pilot on STS-61C in January 1986, and STS-31, April 1990, and was Mission Commander on STS-45, March 1992.

Frederick D. Gregory, NASA Astronaut and Colonel, USAF, was named to the position of Associate Administrator, Office of Safety and Mission Quality, replacing George A. Rodney who is retiring in June. In this position Gregory will be responsible for the safety and mission quality for all NASA programs and activities, and for the direction of reporting and documentation of problem identification, problem resolution and trend analysis. Gregory is a 1964 U.S. Air Force Academy graduate and received a Master's Degree in Information Systems from George Washington University, Washington, D.C., in 1977. A veteran of three Space Shuttle missions, he served as Pilot on STS-51B, April 1985, and was the Spacecraft Commander on STS-33, November 1989, and STS-44, November 1991.

Goldin also announced the appointment of Alison L. McNally and Deidre A. Lee as Executive Officers.

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400

**Terri Sindelar**  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

For Release

April 29, 1992

N92-37

## **EDITORS NOTE: ORBITER-NAMING PARTICIPANTS REUNITE**

The two national winning student teams and many of the educators who participated in NASA's Orbiter-Naming Program will meet May 5-7. News media are invited to attend the May 5 reception at the Holiday Inn, Indialantic, Fla., and to interview the students and participants at the Kennedy Space Center Banana Creek launch viewing site May 7, prior to the launch of Shuttle mission STS-49.

The name of new Space Shuttle orbiter, Endeavour, resulted from a nationwide orbiter-naming competition supported by educational projects created by student teams in elementary and secondary schools. The two national winning teams were selected from over 6,100 entries involving more than 71,000 students.

Congressman Tom Lewis (R-Fla.), who introduced legislation in March 1986 which called for the replacement orbiter to be named from suggestions submitted by students, has been invited to be the featured speaker during the 5:30-7:30 p.m. EDT reception on May 5.

In addition, the nine students of the Senatobia Middle School, Senatobia, Miss., team and eight members of the Tallulah Falls School, Inc., Tallulah Falls, Ga., team will present their projects. These teams were the Division I (K through 6) and Division II (Grades 7-12) winners respectively in the orbiter-naming competition.

To arrange interviews with the students or participants, contact Terri Sindelar at 407/777-4100.

- end -

Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

For Release  
April 30, 1992

Dane Konop  
National Oceanic and Atmospheric Administration, Silver  
Spring, Md.  
(Phone: 301/713-2465)

RELEASE: 92-55

## **U.S. STUDY ENHANCES CONCERN FOR NORTHERN OZONE DEPLETION**

Results of a recently completed U.S. multi-agency aircraft study indicate that the ozone shield of the Northern Hemisphere is increasingly vulnerable to depletion by man-made chemicals, said Dr. James Anderson of Harvard University, the study's Mission Scientist.

This 7-month study indicates the magnitude of human-caused ozone losses in the Arctic depends on the severity and length of the polar winter, which varies from year to year. The research team found that during this winter, the Arctic was primed chemically for ozone loss by mid-January, but the early warming of that region that occurred in late January precluded major ozone depletion.

The study also revealed important evidence supporting the conclusion that ozone decreases at mid-latitudes are associated with increased levels in chlorine and bromine in the stratosphere. Since concentrations of human-made, ozone-depleting chemicals will continue to rise during the 1990s despite current regulations, it is increasingly likely in coming years that substantial Arctic ozone losses will occur during particularly cold, protracted winters and that mid-latitude ozone trends will continue to decline.

The 80 scientists of the second Airborne Arctic Stratospheric Expedition (AASE II) used two NASA aircraft to examine the ozone-related chemistry and air motions of the lower stratosphere from early October 1991 through late March 1992. The flights, largely based out of Bangor, Maine, covered latitudes from south of the equator to the North Pole and extended from Norway to Alaska. NASA's Dr. Michael Kurylo, the AASE II Program Manager, said these extensive measurements, combined with satellite and meteorological data, provide the first detailed picture of the factors that drive changes in the Arctic ozone layer from fall, through winter, and into spring.

Stratospheric ozone is destroyed by chemical reactions when exposed to chlorine monoxide (ClO) and bromine monoxide (BrO) in the presence of sunlight. The chlorine monoxide arises primarily from chlorofluorocarbons (CFCs), and the bromine monoxide is produced in part by halons. CFCs and halons are industrially produced chemicals that have many common uses, including propellants, refrigerants and fire suppressants.

Ground-based and airborne experiments in 1986 and 1987 demonstrated that these chemicals are the cause of the large seasonal ozone losses in the Antarctic spring. In January-February 1989, flights out of Stavanger, Norway, found that ClO concentrations could be as high in the Arctic winter as in the Antarctic spring. Yet ozone losses observed in the Arctic winter in 1989 were much smaller than those of the Antarctic in spring, suggesting the need to better understand the seasonal changes in ozone and the gases that affect it. The current aircraft campaign with its extended seasonal coverage, refined abilities to separate chemical and air-motion effects, and several critical new instruments have taken a much closer look at how such chemical species, against the backdrop of complex air motions, can cause ozone losses in the Arctic and Northern latitudes.

Over the past several years, the results from the suite of instruments on the high-flying ER-2 aircraft and the far-ranging DC-8 aircraft have demonstrated that the ClO abundances are greatly elevated in polar regions by the presence of small particle polar stratospheric clouds (PSCs). Chemical reactions that occur on the surfaces of these particles cause more of the chlorine from CFCs to appear as ClO, rather than as the less-reactive forms such as chlorine nitrate and hydrochloric acid. Rapid ozone loss occurs when air perturbed by these surface reactions is exposed to sunlight.

The AASE II observations within the Arctic region revealed how the ClO abundances changed with season. The unique sequence of aircraft flights demonstrated that the ClO concentrations grew during the fall-to-winter months. By mid-January, the ClO abundances had reached values that were higher than any seen previously, either in the Arctic or the Antarctic. Though large ozone losses were not observed then only because much of the Arctic region was still dark, the study revealed an unprecedented potential for ozone loss if this air were to be exposed to extensive sunlight. The somewhat early warming of the stratosphere in late January reduced the ClO abundances considerably before the sunlight returned, averting extensive Arctic ozone losses this year.

The scientists have concluded that the ClO growth seen in the Arctic during AASE I in 1989 and AASE II this year is likely to occur each winter. In years for which these high levels of Arctic ClO persist into the sunlit months of spring (February and March), chemical models predict that ozone depletion will occur. The temperature record of the Arctic shows that winters with cold stratospheric temperatures in February are not uncommon.

While ClO was still high in January, there was some exposure to Arctic sunlight, apparently resulting in 10 to 20 percent ozone loss at flight altitudes. High-ClO air could be traced to regions of high PSCs. Less ozone-depleting conditions were found to be linked to air that had not been exposed to PSCs. Thus, the AASE II mission has established in detail how and when ozone losses can occur in the Arctic. Because the atmosphere of the Arctic region is so variable, the full extent of overall ozone losses this year will require further assimilation of the extensive data set of AASE II and other sources.

Higher-than-expected ClO amounts also were found on flights southward to mid latitudes. The data indicated that these elevated levels also were due to chemistry occurring on the surfaces of particles, which at these latitudes were not PSCs, but particles of sulfate in the lower stratosphere. The aircraft studies also showed that the chemistry occurring on these sulfate particles lowers the abundances of the nitrogen oxides in the region, said Dr. David Fahey, one of the scientists from the National Oceanic and Atmospheric Administration (NOAA).

Like ClO, nitrogen oxides destroy stratospheric ozone. Unlike ClO, stratospheric nitrogen oxides are produced largely by natural processes. At these sunlit mid latitudes, elevated abundances of ClO, coupled with observed BrO abundances and reduced levels of nitrogen oxides, suggest that a larger portion of the ozone destruction taking place there is likely to be due to human influences rather than to natural ones.

The AASE II observations are consistent with the view expressed in the recent United Nations Environment Programme report that implicates ClO and BrO in the downward ozone trends observed over mid latitudes by satellites and ground-based measurements over the past several years. The mission results also underscore the need to include such additional ozone-depleting processes in models used to predict for governments the future ozone losses associated with regulatory strategies regarding CFCs, their substitutes, other chlorine-containing gases and the bromine-containing halons.

The eruption of Mount Pinatubo in the Philippines has increased the abundance of natural sulfate particles, potentially enhancing ozone losses due to chemical reactions that occur on particle surfaces. Ozone levels were reduced within layers of Mount Pinatubo aerosols in the tropics, but further analyses are needed before the eruption's effect on the ozone layer can be assessed quantitatively. However, since volcanic particles settle out of the stratosphere in 3 to 5 years, any ozone loss caused by Mount Pinatubo will be short lived in contrast to the chronic effect of the long-lived CFCs and halons.

The researchers noted that within the Arctic region, the particles from Mount Pinatubo likely play a minor role in perturbing the ozone-depleting chemistry compared to the role of the abundant PSCs. No direct injection of chlorine itself by the volcano was observed at any latitudes.

The AASE II mission was a multi-agency effort involving scientists and support from NASA, NOAA and the National Science Foundation, scientists from several universities and support from the chemical industry's Alternative Fluorocarbon Environmental Acceptability Study. The NASA aircraft are managed by the Ames Research Center, Moffett Field, Calif., for NASA's Office of Space Science and Applications.

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400

Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

For Release  
April 30, 1992

Jessie Katz  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-5566)

James H. Wilson  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 92-56

## **NASA SPACECRAFT FINDS LARGE ARCTIC OZONE DEPLETION AVERTED**

A rise in stratospheric temperatures in late January apparently prevented severe ozone depletion from occurring in the Arctic this year, says a scientist at NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif. The temperature increase is thought to eliminate polar stratospheric clouds, microscopic ice particles that can sustain high levels of ClO and lead to the large and fast ozone depletion characteristic of the Antarctic.

An alarming spread of chlorine monoxide (ClO), the dominant form of chemically active chlorine that destroys ozone, was detected in January over Greenland, the north Atlantic, northern Europe and Russia by the Microwave Limb Sounder (MLS) on NASA's Upper Atmosphere Research Satellite (UARS).

When the MLS continued its monthly northern hemisphere observations in mid-February, the ClO was reduced from mid-January, said Dr. Joe Waters, Microwave Limb Sounder principal investigator at JPL. Although the January data indicated severe ozone depletion was possible during the northern winter of 1991-92, Waters said his recent ozone data indicate that it did not occur. However, because the sources of chlorine are long-lived in the stratosphere, ozone depletion remains a threat in future years.

"This tells me that conditions in the upper atmosphere are in a very delicate balance," said Waters. "With so much chlorine in the stratosphere, a slight temperature difference can make an enormous difference in the potential for ozone depletion."

- more -

In February, "lesser abundances of ClO were detected," said Waters. "These were still very much at an unwanted level and of substantial concern. But they were not at the levels we saw in January which, had they persisted, could have led to a substantial northern ozone depletion this year."

Scientists believe most of the chlorine in the stratosphere is from the release of commercially produced chlorofluorocarbons (CFCs). A delicate combination of sunlight, ice clouds and weather conditions can initiate reactions that lead to ozone depletion. The CFCs also are believed to be involved worldwide in a slower chain of reactions that are eroding ozone on a global scale and do not require the special conditions inside a polar "hole."

In the Antarctic, said Waters, conditions are regular enough that scientists can predict with some confidence the annual formation of an ozone hole. In the south, winter stratospheric winds blow mainly in an east-west direction and form a vortex, or circular air pattern, around the Antarctic. The vortex inhibits warmer air from entering polar regions.

"The air in this vortex gets very, very cold in the southern winter with no sunlight," said the atmospheric scientist. "So when sunlight arrives around early September, both conditions -- cold and sunlight -- are present that, in an atmosphere which has already been loaded with chlorine monoxide, can lead to an ozone hole." The southern ozone hole generally persists through October and dissipates in November or December as the air warms and the vortex breaks up.

The scenario is not so simple in Earth's northern hemisphere, where the more complex pattern of continents and oceans cause circulation patterns with a more variable and less intense northern vortex.

Because the northern circulation patterns are more complicated than in the south, "We cannot yet predict details of ozone depletion in the northern polar vortex," said Waters. "We know the season when severe ozone depletion might be expected, but it's like predicting hurricanes -- you may know the general season, but you can't predict the exact time, location and severity. The problem will grow as more chlorine is added to the atmosphere."

Although the northern winter is over for this year, Waters said he plans to continue monitoring the global situation, closely watching his satellite data for years to come.

The UARS spacecraft, launched Sept. 12, 1991, carries 10 instruments to study the chemistry, dynamics and energetics of the upper atmosphere. Its mission is to provide scientists the first comprehensive, three-dimensional global picture of the upper atmosphere, including the processes of ozone depletion.

- 3 -

UARS is managed by NASA's Goddard Space Flight Center, Greenbelt, Md., for the Office of Space Science and Applications. JPL, with collaboration from organizations in the United Kingdom, developed and operates the Microwave Limb Sounder.

- end -

EDITOR'S NOTE: A photo (color: 92-HC-254; B&W: 92-H-290) depicting abundances of stratospheric chlorine monoxide during the winter of 1991-92, measured by the Microwave Limb Sounder on UARS is available to accompany this release at the NASA Headquarters Broadcast and Audio-visual Branch by calling 202/453-8373.

Also available is a photo (color: 92-HC-253; B&W: 92-H-289) depicting ozone levels measured over two 4-year periods by NASA's Total Ozone Mapping Spectrometer instrument aboard the Nimbus-7 satellite.

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/453-8536)

For Release

May 1, 1992

NOTE TO EDITORS: N92-38

## **STS-49 NASA NEWSROOM HOURS AND PROCEDURES FOR AFTER-HOURS NEWS CONFERENCE PARTICIPATION**

During Shuttle Mission STS-49, the NASA newsrooms supporting the flight will have extended hours of operation. However, staffing and budget constraints will force some NASA newsrooms to be closed in the evenings and on weekends.

To permit media to ask questions in daily mission press briefings, the following procedures are to be used when a newsroom is closed and it is not possible for the media to ask questions directly of press conference briefers.

Media should write down their name, affiliation and question(s) and facsimile the question(s) to the newsroom at the NASA Center originating the briefing at least 1/2 hour prior to the start of the news conference. Facsimile numbers are listed in this announcement. The question(s) will be given to the appropriate briefer who will read the question over NASA select and answer it or refer it to the appropriate expert. Newsroom personnel WILL NOT forward verbal questions to the briefing participants.

In an effort to facilitate the flow of communications, listed below are the times each newsroom will be open along with contact phone numbers.

### **STS-49 NEWSROOM OPERATIONS** (Based on 5/7/92 launch)

#### **NASA HEADQUARTERS & GODDARD SPACE FLIGHT CENTER**

News media in the Washington Metropolitan area are advised that the newsrooms at NASA Headquarters and Goddard Space Flight Center are planning to be open regular business hours only. Since many of the significant STS-49 events occur in the evening and possibly on a Saturday or Sunday, news media wishing to cover the mission need to make special arrangements.

- more -

During the STS-49 mission, INTELSAT will maintain media viewing facilities at its Washington, D.C. headquarters. The media center will provide continuous coverage of NASA Select television and will participate in the nightly NASA mission status briefings. News media must be INTELSAT-accredited in order to use the media center. To obtain accreditation, news media should contact INTELSAT public affairs at 202/944-7835.

\*\*\*\*\*

#### KENNEDY SPACE CENTER, FLA.

##### Operating Hours

L-2	8:00 a.m. - 5:00 p.m. EDT
L-1	8:00 a.m. - 5:00 p.m. EDT
Launch day	6:00 a.m. - 12:00 midnight EDT
On-Orbit (weekdays)	7:00 a.m. - 12:00 midnight EDT
On-Orbit (weekends)	3:00 p.m. - 12:00 midnight EDT
Landing day	7:00 a.m. - 12:00 midnight EDT

##### Phone Numbers

Newsroom:	407/867-2468
Facsimile:	407/867-2692
Code-A-Phone:	407/867-2525

##### After Hours:

Dick Young	407/452-5141
Karl Kristofferson	407/267-9302

\*\*\*\*\*

#### JOHNSON SPACE CENTER, HOUSTON

##### Operating Hours

L-2	8:00 a.m. - 5:00 p.m. CDT
L-1	8:00 a.m. - 5:00 p.m. CDT
Launch day	8:00 a.m. - 12:00 midnight CDT
On-Orbit (weekdays)	7:00 a.m. - 12:00 midnight CDT
On-Orbit (weekends)	7:00 a.m. - 12:00 midnight CDT
Landing day	7:00 a.m. - 8:00 p.m. CDT

##### Phone Numbers

Newsroom:	713/483-5111
Facsimile:	713/483-2000
Code-A-Phone:	713/483-8600

##### After Hours:

Jack Riley	713/471-0624
Steve Nesbitt	713/286-5971

MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.

Operating Hours

L-2	8:00 a.m. - 5:00 p.m. CDT
L-1	8:00 a.m. - 5:00 p.m. CDT
Launch day	8:00 a.m. - 8:00 p.m. CDT
On-Orbit (weekdays)	8:00 a.m. - 5:00 p.m. CDT
On-Orbit (weekends)	Closed
Landing day	8:00 a.m. - 8:00 p.m. CDT

Phone Numbers

Newsroom:	205/544-0034
Facsimile:	205/544-5852
Code-A-Phone:	205/544-6397

After Hours:

Dom Amatore	205/461-7833
Dave Drachlis	205/881-9302

\*\*\*\*\*

DRYDEN FLIGHT RESEARCH FACILITY, EDWARDS, CALIF.

Operating Hours

L-2	7:30 a.m. - 4:00 p.m. PDT
L-1	7:30 a.m. - 4:00 p.m. PDT
Launch day	7:30 a.m. - 7:30 p.m. PDT
On-Orbit (weekdays)	7:30 a.m. - 4:00 p.m. PDT
On-Orbit (weekends)	7:30 a.m. - 4:00 p.m. PDT
Landing day	7:30 a.m. - Landing + 3 hours

Phone Numbers

Newsroom:	805/258-3449
Facsimile:	805/258-3566
Code-A-Phone:	805/258-2564

After Hours:

Nancy Lovato	805/948-2957
Don Haley	805/943-5817

# NASA News



National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400

For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/453-1548 )

May 1, 1992

EDITORS NOTE: N92-39

## **VIDEO OF SUN'S CORONA ACTIVITY AVAILABLE**

Images of the Sun's corona, taken by a NASA instrument on the Japanese satellite Yohkoh, have been made into a dramatic video release.

Taken in x-ray wavelengths by NASA's Soft X-ray Telescope, the video shows the Sun's "soft" or low energy x-ray activity. Soft x-rays are produced when the temperature of the corona's gases is hotter than about 1 million degrees Celsius (2 million degrees Fahrenheit). Temperatures can range as high as 10 million to 30 million degrees Celsius when a solar flare is active.

Yohkoh, launched Aug. 30, 1991, from Kagoshima Space Center in Japan, is a cooperative mission between Japan, the United Kingdom and the United States.

The 6-minute Soft X-ray Telescope video is available from NASA Headquarters Broadcast and Imaging Branch by calling 202/453-8594.

- end -

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
AC 202 453-8400



Debra J. Rahn  
Headquarters, Washington, D.C.  
(Phone: 202/453-8455)

For Release

May 1, 1992

Frank O'Donnell  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

NOTE TO EDITORS: N92-40

## **SPACE AGENCY FORUM ON THE INTERNATIONAL SPACE YEAR CANCELLED**

The fifth meeting of the Space Agency Forum on the International Space Year (SAFISY) and the associated press conference scheduled at the Ritz-Carlton Huntington Hotel, Pasadena, Calif., May 4-6, 1992, have been cancelled due to the disruption of transportation services in the area.

- end -

For Release

Dwayne C. Brown  
Headquarters, Washington, D.C.  
(Phone: 202/453-8956)

May 1, 1992

RELEASE: 92-57

## **EIGHT FIRMS NAMED GEORGE M. LOW TROPHY FINALISTS**

Eight finalists have been chosen for the 1992 George M. Low Trophy -- NASA's Quality and Excellence Award. Created in 1984, it was the first national award to recognize the quality of an organization's services and products. The finalists are:

Cray Research, Inc., Customer Service, Engineering, and  
Manufacturing Divisions, Chippewa Falls, Wisc.

Honeywell Inc., Space and Strategic Systems Operation, Clearwater,  
Fla.

IBM Federal Sector Division, Houston

McDonnell Douglas Space Systems Co., Kennedy Space Center, Fla.

Paramax Systems Corp., Space Systems Operation, Houston

Rocket Research Co., Redmond, Wash.

Stanford Telecommunications, Inc., Reston, Va., (Small Business)

Technical Analysis, Inc., Houston, (Small Business)

The award recognizes both NASA's large and small prime contractors, subcontractors and suppliers for outstanding achievement in quality and productivity improvement and Total Quality Management (TQM). Key goals of the award are to internalize quality and productivity practices and TQM processes throughout NASA and the agency's contractors and to transfer performance improvement methods of the award recipients to others.

- more -

"I'm a true believer in the George M. Low Trophy process and the TQM philosophy. The award recognizes superior performance by contractors and facilitates the transfer of successful strategies throughout the country. These strategies insure that quality products and services accommodate our various customers to the highest degree," said NASA Administrator Dan S. Goldin.

George A. Rodney, NASA Associate Administrator for the Office of Safety and Mission Quality, announced the finalists after an intensive 6-month application and review process. "Since establishing NASA's Excellence Award, many private and government agencies have created their own quality award. More and more organizations are incorporating continuous improvement at the top of their goals and vision," said Rodney.

The award process now advances to the third phase in which validation teams visit finalists' facilities to verify performance achievements and process attainments.

Following the review and recommendations of the Low Trophy Evaluation Committee, NASA's TQM Steering Committee, comprised of Center Directors and Headquarters Associate Administrators, will make the final recommendation for award recipients to the NASA Administrator.

Goldin will announce the award recipients at the ninth annual NASA/Contractor Conference on Oct. 20, 1992, in Pasadena, Calif. There is no limit to the number of awards which can be given among the finalists.

The recipients of the 1991 George M. Low Trophy were Thiokol Space Operations, Brigham City, Utah and Grumman Technical Services Division, Titusville, Fla., a subcontractor to Lockheed, Space Operations Co., Kennedy Space Center, Fla.

Previous recipients of the award have been Lockheed Engineering and Sciences Co., Houston; Rocketdyne Division, Rockwell International Corp., Canoga Park, Calif.; Martin Marietta Manned Space Systems Co., New Orleans; IBM's Systems Integration Division, Houston; Rockwell International Corp., Space Systems Division, Downey, Calif. and Marotta Scientific Controls, Inc., Montville, N.J.

The award is administered for NASA by the American Society for Quality Control, Milwaukee, Wisc., a professional association and a worldwide leader in development, promotion and application of quality and quality-related technologies.

-end-



For Release

Sue Richard  
Headquarters, Washington, D.C.  
(Phone: 202/453-8364)

May 5, 1992

N92-41: NOTE TO EDITORS

## **NASA MOURNS PASSING OF THOMAS O. PAINE**

Upon learning of the death of Dr. Thomas O. Paine, the third Administrator of NASA, NASA Administrator Daniel S. Goldin issued the following statement:

"The Agency mourns the death of Tom Paine, an outstanding American. Over the years, I had the privilege of working with Tom personally. I found him to be a man of vision and integrity. Tom's leadership of NASA through the first several moon landings was nothing short of exemplary and later as Chairman of the National Commission on Space in the mid-1980s, his direction of this Presidentially appointed group formulated a bold agenda to carry America's civilian space enterprise into the 21st century.

Within the past six months, the nation has been saddened by the passing of three former NASA Administrators - Jim Fletcher in December, Jim Webb in February and now Tom Paine. Their accomplishments and legacies will long endure."

-end-

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400

Sue Richard  
Headquarters, Washington, D.C.  
(Phone: 202/453-8364)

For Release  
May 6, 1992

RELEASE: 92-58

## **DRUYUN NAMED CHIEF OF STAFF; BUSH TO HEAD PROCUREMENT OFFICE**

NASA Administrator Daniel S. Goldin announced today that he has selected Darleen A. Druyun as his Chief of Staff. Druyun currently serves as Assistant Administrator for Procurement, where she has led an aggressive and innovative reform of NASA procurement practices. "NASA intends to be world class in everything we do, and I view this appointment as being truly world class," Goldin said.

In this newly created position, Druyun will conduct strategic planning for the Administrator. She also will provide continuity in the Administrator's office and will facilitate communications between the Administrator's office and senior staff members, as well as with private sector executives and international visitors. In addition, the Chief of Staff will focus on internal NASA Headquarters management and operations, aiming to increase the efficiency of the organization. The appointment is effective immediately.

"Mrs. Druyun will focus on improving overall efficiency at NASA Headquarters," Administrator Goldin said. "I believe we cannot ask the NASA field centers and contractor teams to undertake efficiency improvements without the active participation and leadership of NASA Headquarters. Mrs. Druyun will spearhead these activities."

The Administrator also announced the appointment of Don G. Bush to replace Druyun as Assistant Administrator for Procurement. He has served as Druyun's deputy since her arrival at NASA last year.

"Don and I developed the NASA procurement initiatives as a team, and he has been their most aggressive and forward-thinking supporter," Druyun said. "I leave our efforts in good hands." Administrator Goldin and Druyun both expressed confidence that the new Assistant Administrator for Procurement will successfully implement the plan for procurement reform initiated in 1991.

- end -

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
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For Release

Dwayne Brown  
Headquarters, Washington, D.C.  
(Phone: 202/453-8956)

May 6, 1992

RELEASE: 92-59

## **PELLERIN APPOINTED TO SAFETY AND MISSION QUALITY POST**

NASA Administrator Daniel S. Goldin today announced the appointment of Dr. Charles J. Pellerin, Jr., to the position of Deputy Associate Administrator for Safety and Mission Quality. In addition, he will serve as Special Assistant to the Administrator for long-range planning. In this capacity, he will work with Assistant Deputy Administrator Charles F. Bolden.

Pellerin has served since 1983 as Director of Astrophysics in NASA's Office of Space Science and Applications. Many of the most complex satellites ever conceived were completed under his leadership and launched in recent years. The scientific results from these missions, which include the Cosmic Background Explorer, Hubble Space Telescope and Compton Gamma Ray Observer, are now changing how we view the universe and humanity's place in it.

Pellerin began his NASA career as an aerospace engineer at the Goddard Space Flight Center, Greenbelt, Md., where he was involved in the engineering of rocket instrumentation and later, in the use of sounding rockets for scientific research. In 1975, he moved to NASA Headquarters and for 5 years managed the development and integration of scientific instrumentation for flight on the Space Shuttle.

In 1974, Pellerin was awarded a Ph.D. in physics from the Catholic University of America. He has received many honors, including the Presidential Rank Award, Catholic University Science Alumni Award and NASA's Outstanding Leadership Medal.

- end -



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For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/453-1549)

May 7, 1992

Keith Koehler  
Wallops Flight Facility, Wallops Island, Va.  
(Phone: 804/824-1579)

RELEASE: C92-6

## **NASA SELECTS PLS FOR BALLOON PROGRAM SUPPORT**

NASA's Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Va., has selected the New Mexico State University, Physical Science Laboratory (PSL) of Las Cruces, N.M., to negotiate a cost contract for the operation and maintenance of scientific balloon facilities and engineering support for the NASA Balloon Program.

The total cost for the 5-year contract, expected to be effective Oct. 1, 1992, is \$65.7 million as proposed by PSL.

The contractor is to provide services at balloon facilities, located in Palestine, Texas, Fort Sumner, N.M. and other semi-permanent domestic and foreign sites.

The contract provides for operational balloon flight support for launching, tracking and recovering of scientific balloons and payloads and engineering support for the NASA Balloon Program at the Palestine site, the Wallops Flight Facility and at PSL.

- end -



Paula Cleggett-Haleim  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

For Release

May 7, 1992

James Elliott  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-6256)

Ray Villard  
Space Telescope Science Institute, Baltimore, Md.  
(Phone: 410/338-4514)

RELEASE: 92-61

## **HST DISCOVERS A HIGH ENERGY JET IN GALAXY NGC 3862**

NASA's Hubble Space Telescope has revealed an unusual and fascinating new optical jet in the nucleus of the elliptical galaxy NGC 3862.

"It appears that we are seeing a new class of phenomenon," says Dr. Philippe Crane of the European Southern Observatory, who discovered the jet in images sent back by the European Space Agency's (ESA) Faint Object Camera on board HST. "The jet-like feature was totally unexpected in this galaxy. This is typical of the kinds of discoveries that were expected from HST." Crane and ESA's Faint Object Camera Instrument Definition Team made the observations.

NGC 3862, also known as 3C264, is a bright radio source and x-ray source. It is the sixth brightest galaxy in a rich cluster of galaxies known as Abell 1367, located at a distance of about 260 million light-years away in the constellation Leo. Previous observations of NGC 3862 taken in radio wavelengths have revealed a jet-like structure that extends for a very long distance.

"Since the jet is only 0.6 arc seconds long (equivalent to the apparent width of a dime located 2.5 miles away), it would have been very difficult to see from a ground-based observatory," says Crane. "The jet also is prominent in ultraviolet light. Both of these characteristics are especially well exploited by the Faint Object Camera (FOC)."

- more -

NGC 3862 was observed with the FOC in the high resolution (f/96) mode, with two filters, on Jan. 25, 1992, . One exposure, taken in yellow-green light, was expected to reveal, outside the nucleus, the distribution of the normal, old stellar population in the galaxy. The second exposure, taken in the near-ultraviolet light, was intended to reveal evidence for a young hot stellar population in the nucleus. To their surprise, the researchers found the optical jet.

Extra-galactic jets are not well understood. They appear to transport energy in a confined beam out from the active nucleus of the host galaxy. Presumably, super-massive black holes are the powerhouses behind jets.

Extra-galactic jets have been detected in radio wavelengths in many active galaxies, but only a few have been seen in optical light. Astronomers do not yet understand why some jets are seen in visible light and others are not. They also would like to understand the connection between radio and optical emissions.

The NGC 3862 jet does not fit easily into the standard model of jets. The new jet is markedly different in several ways from the optical jet seen in M87 - a galaxy previously studied in detail by HST. The NGC 3862 jet is about 750 light-years long, compared to a length of 5,000 light-years for the M87 jet. The jet in M87 is brighter at redder wavelengths because it emits reddish synchrotron radiation produced by high-speed electrons spiraling in the magnetic field which confines the jet. The NGC 3862 jet, however, is much brighter in ultraviolet light, relative to visual light.

"Further observations will be needed to clarify the nature of the emission seen in this jet" says Crane. This new type of jet suggests that astronomers are seeing a new and unexpected phenomena in galactic nuclei.

The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency.

- end -

EDITORS NOTE: A photograph of NGC 3862 is available to media representatives by calling NASA Headquarters Audio/Imaging Branch on 202/453-8375.



For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/453-1549)

May 7, 1992

Kari Fluegel  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 92-62

## **NASA STUDIES TEAM PERFORMANCE IN 30-DAY UNDERSEA MISSION**

The Florida Keys may not seem as distant as the Moon, but for four men during the next 30 days, it might as well be.

During "La Chalupa 30," sponsored by the Marine Resources Development Foundation (MRDF) of Key Largo, Fla., four men will conduct investigations in an underwater habitat without any direct outside human contact for 30-days, giving the Behavior and Performance Laboratory at NASA's Johnson Space Center, Houston, the opportunity to study team performance as part of its continuing investigation to identify pertinent psychological issues for long duration space flight.

At present, NASA employs passive studies to develop its knowledge base on long-term team performance and human behavior, such as talking to crew members of existing remote facilities including polar expeditions. Those studies, however, have progressed to the point at which researchers are ready to test improved behavioral collection methods, said Dr. Al Holland, Head of the Behavior and Performance Laboratory.

"The mission will serve as an environment which is analogous to future extended space missions on the Shuttle or Space Station," Holland said. "This project is primarily a testbed for field data collection methods and procedures. The information collected will assist investigators in conducting further studies in field environments which are of longer duration and possibly in more remote areas."

- more -

The four aquanauts will live and work in the undersea laboratory with regular excursions into the lagoon to perform the in-the-water portion of their marine research projects -- an analogue to extravehicular activity during space flight. They will be in contact with surface crews via voice and video links, but no direct contact will occur for the duration of the test.

The behavioral investigations address four primary areas pertinent to extended missions in confined environments: individual health and well-being, work, team maintenance and data collection methods.

Tests looking at individual health and well being include studies of sleep, cognitive functioning and stress, while those focusing on team maintenance will collect individuals' perceptions on the state of the team's functioning, communication, leadership and social climate. Perceptions of work organization also will be collected and investigations of methodology will help investigators evaluate the different ways of collecting behavioral information from people in remote environments.

MRDF is providing the 3,300-cubic-foot underwater habitat, originally named La Chalupa. Formerly a research station operating off the coast of Puerto Rico, the facility has been used as a commercial undersea lodge since 1986.

The aquanauts, all recruited by MRDF, are Chris Olstad, 37, Mission Commander and an MRDF biologist; Richard A. Presley, 33, Deputy Crew Commander and a hydroponics developer with BioLabs in Key Largo; Bill Soeffing, 35, a cell biologist at Sioux Falls College, Sioux Falls, S.D.; and John Conant, 34, a hyperbaric emergency medical technician from Fort Meyers, Fla.

"By the end of the 30 days, we will have a better understanding of the viability of certain field methods, hardware and software," Holland said. "We also will be in a better position to establish guidelines and requirements for 30-day space missions."

- end -

NOTE TO EDITORS: Planning is in progress for a press day including surface facility tours and a press conference with the aquanauts sometime during the 30-day mission. For more information about the press conference call MRDF's Mark Ward on 305/451-1139.

For Release

Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

May 8, 1992

RELEASE: 92-63

## **NASA ANNOUNCES PLANS FOR SMALL PLANETARY MISSIONS**

NASA today delivered a report to the U.S. Senate outlining a shift in emphasis towards smaller, lower cost and more frequent planetary missions. The Small Planetary Mission Plan, which was requested by the Senate Committee on Appropriations, Subcommittee on VA, HUD and Independent Agencies chaired by Sen. Barbara Mikulski (D-Md.), describes two proposed missions that NASA has selected for preliminary studies leading to launches in 1996 and 1998.

The two missions, part of the Discovery program, are the Mars Environmental Survey (MESUR) Pathfinder, planned for launch in 1996, and the Near Earth Asteroid Rendezvous (NEAR), planned for a 1998 launch. Phase A studies of the MESUR Pathfinder mission have been awarded to NASA's Jet Propulsion Laboratory, Pasadena, Calif. (JPL). The Applied Physics Laboratory of Johns Hopkins University, Baltimore, Md. (APL), has been awarded Phase A studies of the NEAR mission.

"We're very excited about this plan," said Dr. Wesley T. Huntress, Jr., Director of NASA's Solar System Exploration Division. "It will enable more opportunities for planetary exploration without a large budget impact. It will allow us to more effectively take advantage of emerging technology and to quickly - and relatively cheaply - undertake new missions of discovery. A significant benefit will be increased student involvement because the shorter project time-frames fit nicely with most academic degree programs."

According to the report, the plan emphasizes a recent change in the character of NASA's Solar System Exploration Division's programs. Most planetary missions of the past 2 decades have involved relatively large spacecraft with broad science goals. There have been only a few such missions per decade. The new, less expensive projects can be launched more often, affording timely new opportunities to many investigators and institutions. They also can fill in gaps in the planetary exploration program and revitalize educational interest in planetary science.

- more -

Small planetary missions, described in the report as the centerpiece of NASA's new planetary programs for the 1990's, are designed to proceed from definition to flight in less than 3 years, combining well-defined objectives, proven instruments and flight systems, strict cost limits and acceptance of a greater level of risk. Most will be implemented by teams including substantial academic representation.

The Discovery missions will be modeled on existing Explorer and Earth Probe programs, with each mission costing no more than \$150 million. The first Discovery mission, MESUR Pathfinder, is envisioned as a technical demonstration and validation flight for the MESUR program, scheduled to begin in 1999. The MESUR program calls for building a network of about 16 small automated surface stations widely scattered around Mars to study the planet's internal structure, meteorology and local surface properties.

NASA is studying the possibility of including a prototype of a Mars micro-rover on the MESUR Pathfinder lander. The micro-rover, currently under joint development by the Solar System Exploration Division and NASA's Office of Aeronautics and Space Technology, would carry a camera and one or two additional scientific instruments. The lander also may include instruments provided by NASA's Office of Exploration to search for subsurface ice and to measure soil toxicity.

A second concept under study, NEAR, would spend up to a year station-keeping with a near-Earth asteroid. The NEAR spacecraft, probably carrying only three instruments, would assess the asteroid's mass, size, density and spin rate, map its surface topography and composition, determine its internal properties and study its interaction with the interplanetary environment.

Other candidate Discovery missions listed in the report include a Venus atmospheric probe, Earth-orbiting planetary telescopes, multiple asteroid/comet flybys and comet reconnaissance missions, a Mars orbiter to study the planet's upper atmosphere and missions to Mars' moons.

Also included in the report to the Senate is the first phase of a program called Toward Other Planetary Systems (TOPS-O), consisting of ground-based observations to search for, identify and examine Jupiter-sized planets around other stars within 50 light-years of Earth. The TOPS-O plan includes development of a second 10-meter telescope at the Keck Observatory in Hawaii and enhanced instrumentation.

The Discovery and TOPS programs are managed by the Solar System Exploration Division of the Office of Space Science and Applications, at NASA Headquarters, Washington, D.C.



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For Release

Mike Simmons  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205/544-0034)

May 8, 1992

EDITORS NOTE: N92-42

## **SKYLAB ASTRONAUTS TO TEST SPACE STATION IN UNDERWATER TANK**

Lending their expertise with long-duration exposure to microgravity, the Skylab IV astronaut crew will participate in a series of underwater tests that will help in the development of Space Station Freedom.

Jerry Carr, Ed Gibson and Bill Pogue will be diving in the 1.32 million-gallon Neutral Buoyancy Simulator at the Marshall Space Flight Center, Huntsville, Ala., which mimics the weightless characteristics of space flight. They will be joined by former Space Shuttle astronaut Bob Springer and former European Space Agency astronaut Wubbo Ockels in tests to evaluate components for use in the Space Station and to practice moving payloads from one module to another using prototype developmental hardware.

The tests will be monitored by engineers representing NASA, the Boeing Defense & Space Group (the prime contractor to NASA and the Marshall Center on Space Station Work Package 1), and international partners from the European Space Agency and the Japanese Space Agency.

A 4-hour period has been reserved from 10 a.m. to 2 p.m. EDT on Wed., May 13 for media to photograph the tests. Additionally, a media availability has been scheduled from 10:30 to 11 a.m. that day for media to interview the former astronauts and test subjects. The media availability and photo opportunity will occur at the Neutral Buoyancy Facility in Building 4705. Media planning to cover these events should come to the Media Services Office, Room 101, in Building 4200 for badging and escort to Building 4705 by 10 a.m. to allow enough set up time.

Carr, Gibson and Pogue spent 84 days in orbit in 1974 - the current record stay in space for American astronauts. Springer flew on Space Shuttle STS-29 and STS-38 missions in March 1989 and November 1990, and Ockels was a payload specialist aboard Shuttle's Spacelab D-1 mission in October 1985.

- end -

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400



Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

For Release  
May 11, 1992

NOTE TO EDITORS: N92-43

## **LOW VISION SYSTEM DEMONSTRATION AND BRIEFING SCHEDULED MAY 13**

A briefing and demonstration of a prototype low vision enhancement system (LVES), cooperatively developed by NASA and the Lions Vision Center at the Johns Hopkins Hospital, Baltimore, will be held 10:30 a.m. EDT Wednesday, May 13, at the Oncology Center Auditorium (Room 119, Wolfe St. entrance) at Johns Hopkins Hospital.

The NASA briefers will be Doug Rickman, NASA Low Vision Project Manager, Stennis Space Center (SSC), Miss.; and John Mannix, Associate Administrator, Office of Commercial Programs, NASA Headquarters, Washington, D.C.

Other briefers will represent the Lions Vision Center, the Veterans Administration and Triad Investors Corp., Baltimore.

The LVES technology, originally developed for possible use on Space Station Freedom, potentially could help millions of Americans afflicted with certain low vision problems.

A videotape illustrating the low-vision enhancement system is available to news media representatives by calling the NASA Broadcast and Imaging Branch on 202/453-1203.

To attend this briefing and for directions to the Oncology Center Auditorium, contact Marc Kusnitz or Joann Rodgers, Johns Hopkins Medical Institutions Office of Public Affairs at 410/955-8665.

- end -

Terri Sindelar  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

For Release

May 14, 1992

Mike Simmons  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205/544-0034)

RELEASE: 92-66

## **NASA CO-SPONSORS NATIONAL SCIENCE OLYMPIAD**

NASA is joining Auburn University in co-sponsoring the 1992 National Science Olympiad to be held at the Auburn, Ala., campus May 15-16. More than 1,500 of the nation's top junior and senior high school students will compete in the 33-event Olympiad, the largest science event in the United States.

The Olympiad is held each year to improve science and technology education by generating enthusiasm for science and math on the same level as that generated by varsity sports. The "intelletes" will compete for Olympic-style medals and scholarships.

Discussing the importance of education, President Bush said, "Because student achievement, especially in science and mathematics, is so important to our nation's future, we must never allow America to settle for less than the gold medal in world academic competition."

NASA is participating in this year's Olympiad, the first to be held in the South, as part of its ongoing support of education and in recognition of International Space Year 1992. The space agency will offer participating students and teachers a pre-event tour of the Marshall Space Flight Center, will display a number of space-related exhibits at the 2-day event, and will conduct a number of educational workshops for the more than 500 attending teachers.

NASA Administrator Daniel S. Goldin said, "We applaud the hundreds of thousands of students and teachers across America who are furthering man's quest for knowledge through exploration and discovery. Like the Science Olympiad, NASA strives to foster students' natural curiosity and joy of discovery by challenging minds with new frontiers. In so doing, NASA is committed to helping America become first in math and science by the year 2000, to encouraging science literacy for all Americans and to safeguarding our nation's competitiveness."

- more -

The Olympiad, to be held on May 16, will consist of events representing three broad areas of science education -- concepts and knowledge, processing and thinking skills, and applications and technology. Applying these skills, "intelletes" will design and build clocks, musical instruments, bridges, flying devices, and vehicles propelled by mousetraps.

In other events, teams and individuals will solve problems using their knowledge in biology, geology, chemistry, physics, astronomy, aerodynamics, computers and technology.

NASA's officials participating in the 2-day Science Olympiad will be Frank Owens, Director of Education, NASA Headquarters, Washington, D.C.; Jack Lee, Director of NASA's Marshall Space Flight Center, Huntsville; and J. A. Bethay, Associate Director of NASA's Marshall Space Flight Center, Huntsville.

A pre-event tour of the Marshall Space Flight Center on May 14 will include visits to the Space Station Freedom mockup, manufacturing facility and Environmental Control and Life Support Systems test area; the Spacelab Mission Operations Control Center; the Payload Crew Training Center; the Neutral Buoyancy Simulator; and the Project LASER Discovery Lab.

Marshall will also display a number of exhibits at the event featuring an array of NASA space vehicles and programs and will provide educational materials to over 500 participating teachers through the Project LASER Mobile Teacher Resource Center.

Additionally, NASA educators will present a number of workshops for attending teachers, including a lunar sample education workshop in which teachers will be certified to borrow samples of lunar soil and rocks for classroom use at no charge.

Also, Marshall and the U.S. Space Camp, with assistance from the Global Change Institute of Aspen, Colo., will present an Olympiad special event that will involve students in verifying NASA's observations of the Earth from space.



For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/453-1549)

May 15, 1992

Jane Hutchison  
Ames Research Center, Mountain View, Calif.  
(Phone: 415/604-9000)

RELEASE: 92-67

## **NASA BED-REST STUDY INVESTIGATES IMPORTANCE OF GRAVITY**

Scientists at NASA's Ames Research Center, Mountain View, Calif., are investigating the importance of gravity to life on Earth. They also are studying whether intermittent exposure to gravity may, as a last resort, help keep future space explorers healthy.

Volunteers in a recently completed study were confined to their beds for 24-hours a day in the head-down position to induce the physical changes associated with exposure to the microgravity of space. Results of the study indicated that these volunteers could avoid the changes simply by standing quietly for 15 minutes of each hour over a 16-hour period. Standing for two hours a day (15 minutes each hour over an 8-hour period) or walking at 3 mph were almost as effective, according to Dr. Joan Vernikos, the study's Principal Investigator and Acting Chief of Ames' Life Science Division.

"The question we must answer is both practical and basic: 'How much gravity, how often and for how long?'" Vernikos said. From a practical perspective, "We must know whether humans need gravity 24 hours a day to remain healthy," she said. If intermittent gravity, which can be provided by an onboard centrifuge, is sufficient, "We won't need a permanently rotating spacecraft to produce a constant gravity force." A rotating spacecraft presents serious design, financial and operational challenges. On a basic level, Vernikos said, this and future studies can help explain gravity's role in the development of life on Earth.

In a series of five 6-day experiments conducted over 8 months with the same male volunteers, the team of investigators compared the effects of gravity's head-to-toe "pull" with or without activity. All the volunteers spent 4 days in bed, with a 6-degree head-down tilt.

- more -

They remained in bed throughout one of the 6-day tests. In other tests, they remained in bed except for either standing quietly by the bed or walking at 3 mph for 2 or 4 hours a day in 15-minute segments.

Vernikos said the results showed the 4-day, head-down bed rest model to be an excellent simulation of many of the early physical responses to the microgravity of space. Changes found in astronauts in space -- including reduced blood volume, fluid and sodium loss, decreased aerobic performance and a tendency to faint upon standing after return to Earth -- also were seen in these bed-rested volunteers. She said changes begin within hours after the volunteers go "head-down" and continue to develop through the next several days.

Vernikos said this study is only the beginning. She and her collaborators plan to conduct similar tests using the large centrifuge at Ames. By having healthy volunteers exercise on a treadmill on the centrifuge, Ames investigators "hope to determine whether exercising under increased gravitational forces will decrease the amount of time required to maintain health and fitness," she said.

By spinning at various speeds, the centrifuge produces forces that exceed the normal gravity force on Earth. Some scientists believe that exercise at such increased gravitational forces may further reduce the daily minimum exposure time needed to prevent the effects of simulated and actual microgravity.

Ames investigators also hope to learn whether passive exposure to an increased gravity force may maintain fitness. "We're trying to learn whether it's the activity or simply the presence of gravity that's most important," she said. She added that results of these tests could have great potential for rehabilitation and treatment of various injuries on Earth, such as fractures.

Vernikos and her collaborators presented the results of this study May 14 in a special panel at the annual meeting of the Aerospace Medicine Association in Miami.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
AC 202 453-8400



For Release

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/453-8536)

May 19, 1992

Jack Riley  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 92-68

## **ASTRONAUT MELNICK TO RETIRE AND LEAVE NASA**

Astronaut Bruce E. Melnick (Commander, USCG) is retiring from the U.S. Coast Guard and will be leaving NASA in July. Melnick has accepted the position of Director, Shuttle Processing Contract Process Improvement Technology with Lockheed Space Operations Co. (LSOC) at Kennedy Space Center (KSC), Fla.

"I am really honored to have been a part of the NASA team for the last 5 years and certainly will miss the close friends I have made in the Johnson Space Center family. My two opportunities to venture into space will provide me with irreplaceable memories for the rest of my life and should bring an invaluable experience base into my new position with LSOC at KSC. I am looking forward to taking on the challenges of space engineering management and family wise, this is an ideal time for us to make the move," Melnick said. He will be involved in the day-to-day processing of Space Shuttle vehicles in his new position.

Melnick flew on Space Shuttle missions STS-41 in October 1990 to deploy the Ulysses Jupiter probe and STS-49 in May 1992 to retrieve, repair and reboost the Intelsat-VI telecommunications satellite. Selected by NASA in June 1987, Melnick was NASA's first U.S. Coast Guard astronaut.

Regarding Melnick's decision to retire, Director of Flight Crew Operations Donald R. Puddy said, "Bruce has been an asset to the program, not only in his flight assignments but also in his technical assignments. He has represented the Astronaut Office at KSC in preparing the Shuttle orbiters' cockpit and middeck for missions and in assembly and checkout of the new Space Shuttle Endeavour at contractor facilities in California. We wish him the best in his new job. His background will be very beneficial to NASA in his new position."

- end -



For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/453-1549)

Embargoed Until  
May 21, 1992

Randee Exler  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-7277)

RELEASE: 92-69

## SCIENTISTS SOLVE STELLAR MYSTERY

U.S. scientists have solved a 20-year-old mystery about the nature of Geminga, one of the brightest emitters of high-energy gamma rays in the sky. Scientists were unclear about the source of Geminga's power and why it shines brightly in gamma rays. Using data from two different spacecraft, scientists now know that the power plant in Geminga is a rotating, 300,000-year-old neutron star.

Dr. Jules Halpern, Columbia University, New York City, and Dr. Stephen Holt, NASA's Goddard Space Flight Center, Greenbelt, Md., report in today's issue of the weekly science journal, Nature, that they have observed x-ray pulsations from Geminga using data from the German/American Roentgen Satellite (ROSAT). These observations firmly establish Geminga as a close cousin of the Crab and Vela nebulae, which also have pulsating neutron stars at their cores. The rotating neutron star produces focussed beams of radiation much like the periodic flashing or pulsating lighthouse beacon.

In a companion paper, an investigative team led by Goddard's Dr. David Bertsch confirms the pulsations using gamma ray data from the Energetic Gamma Ray Experiment (EGRET) on NASA's Compton Gamma Ray Observatory and further estimate the age of Geminga as 300,000 years. "With this discovery, we consider the mystery of Geminga largely solved," said Halpern.

Geminga was discovered 20 years ago in the first high-energy gamma ray survey of the sky conducted with NASA's Small Astronomical Satellite-2. Located only a few degrees from the Crab nebula, one of the brightest x-ray and gamma ray sources in the sky.

- more -

Geminga is even brighter than the Crab in gamma rays. Because it has no obvious optical or x-ray counterpart like the Crab nebula for example, it was given the name Geminga, which means "it isn't there" in Milanese Italian dialect. With virtually all of its power emitted in gamma rays, its nature has been a true mystery for 20 years.

Several years ago, a very weak x-ray source was suggested as a potential identification for Geminga on the basis of approximate positional coincidence. Using the ROSAT observatory, Halpern and Holt discovered that the x-ray intensity of this source is modulated with a period of 237 milliseconds, more than seven times longer than the period of the pulsar in the Crab nebula and three times longer than the pulsar in the Vela nebula.

The pulsations are the key to understanding the nature of Geminga. The Crab and Vela nebulae are supernova remnants powered by converting the kinetic energy of pulsars at their centers into radiation that generally includes the whole electromagnetic spectrum. Why Geminga is powerful only in gamma rays is not certain, but the newly discovered pulsar firmly establishes Geminga as a close cousin of the Crab and Vela nebulae.

Bertsch and the EGRET team confirmed that the gamma ray emission from the source modulated with the same period. Their observations also allowed the scientists to measure the rate at which the neutron star is slowing, providing an estimate of the age of the supernova that created the neutron star. This technique determined the age of Crab and Vela to be 1,000 and 10,000 years, respectively. Geminga was estimated to have an age of 300,000 years.

This discovery not only explains the nature of Geminga, but suggests that many of the remaining unidentified gamma ray sources in the Milky Way galaxy also may be neutron stars. Although nearly all pulsars are discovered because of their strong radio signals, Geminga is apparently silent in the radio band. It is possible that Geminga is not unique in this regard. The ROSAT and Compton observatories will search for additional members of this emerging class of gamma ray pulsars.

ROSAT, a cooperative project between NASA and Germany, was launched on a Delta launch vehicle from Cape Canaveral Air Force Station, Fla., on June 1, 1990. The Compton Gamma Ray Observatory was launched on the Space Shuttle Atlantis from the Kennedy Space Center, Fla., on April 5, 1991. The Goddard Space Flight Center manages the U.S. participation in the ROSAT program and the Compton Gamma Ray Observatory for NASA's Office of Space Science and Applications, Washington, D.C.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
AC 202 453-8400



For Release

Drucella Andersen  
Headquarters, Washington, D.C.  
(Phone: 202/453-8613)

May 21, 1992

RELEASE: 92-70

## **MADE IN DETROIT -- FLOWN BY NASA**

When NASA's sleek SR-71 research aircraft gets ready to fly, a deafening roar booms across the concrete runway apron -- not from the jets themselves, but from the two 454-cubic-inch Chevrolet V-8 engines that crank up the plane's powerplants.

The SR-71 starter cart is just one example of the innovative ways that NASA has put off-the-shelf automotive technology to work in its aeronautics and space research programs. During the last 30 years, the high-tech agency has used a variety of auto products from shock absorbers and brake light switches to entire cars and truck trailers.

To test the flying qualities of the M2-F1 lifting body -- ancestor of today's Space Shuttle -- NASA enlisted an automobile to get the craft airborne. NASA's Flight Research Center (now Ames-Dryden Flight Research Facility), Edwards, Calif., bought a stripped-down Pontiac Catalina convertible to use as a tow vehicle for the M2-F1. The engine was tuned for high performance, rollbars were added and other modifications were made.

The Pontiac first towed the M2-F1 aloft on April 5, 1963, roaring across the dry lakebed at 114 miles per hour, about the same speed as an early Cessna 150. During the next 4 months, the car hauled the tubby craft into the air on more than 100 other test hops for a total flight time of about 4 hours. The Catalina's gas mileage was not good -- less than 4 miles per gallon.

NASA's first "hot rod" ended its career in 1968 doing spins on wet and dry pavement at NASA's Wallops Flight Facility, Wallops Island, Va. The tests were part of a highway safety study on skid resistance that NASA did for the Virginia Highway Research Council.

- more -

NASA also has used a 1961 Ford Fairlane, a 1967 Plymouth Fury wagon and a 1969 Ford XL sedan in research to predict aircraft braking ability and to study tire friction. NASA's Langley Research Center, Hampton, Va., modified the cars by installing brake line cutoff valves that let one diagonal pair of wheels brake while the opposite pair rolled free.

The Fairlane studied tire hydroplaning in the mid-1960s. The Plymouth and Ford XL performed locked-wheel skids at high speeds in runway friction tests. Engineers correlated the readings from special onboard recorders with data from specially instrumented aircraft.

The 427-cubic-inch Ford XL has been a real workhorse. Though it has only 46,000 miles on its odometer, the car has made thousands of test runs, usually braking from about 60 miles per hour to a complete stop. In an early task, the Ford, proudly emblazoned with a NASA logo like the agency's research airplanes, tested 50 runways in the United States, England, Germany, Italy and Spain under various weather conditions. The 1968 program involved NASA, the Air Force and the Federal Aviation Administration.

More recently, the Ford paved the way for Shuttle landings with runway friction checks at NASA's Kennedy Space Center, Fla., Ames-Dryden Flight Research Facility and on the gypsum surface at White Sands Space Harbor in New Mexico. The car also has helped find the cause of several runway accidents in support of inquiries by the National Transportation Safety Board, the Navy and the Air Force.

The Ford still serves NASA at Langley. Future tasks for the car include studies of how anti-snow and ice chemicals and aircraft deicing fluids affect runway friction, tests to help define the effect of natural rainfall on tire friction and possible use in aircraft accident investigations where traction may be a factor.

From the mid-1970s to the mid-1980s, the engine, front-wheel-drive and frame of an Oldsmobile Toronado has helped NASA study the problem of wake vortices in Langley's Vortex Research Facility. Wake vortices are funnels of air streaming from an aircraft's wings that can affect the control of planes flying behind. The Toronado hardware powers a carriage that pulls detailed airplane models through a 300-foot test section while laser beams illuminate and measure the airflow. The engine itself, beefed up with improved carburation and racing parts, churns out about 500 horsepower.

Ames-Dryden has four of the carts that ground crews use to start the engines of NASA's SR-71 "Blackbirds." Each cart has two Chevrolet V-8s, upgraded with hotter plugs and coils, that drive through two 350 turbo automatic transmissions. About 10 years ago, the Chevy motors and transmissions replaced the original Buick engines and Dynaflo transmissions while the carts were still in Air Force service.

NASA's use of auto components sometimes has been a matter of necessity. In 1978, two Highly Maneuverable Aircraft Technology (HiMAT) remotely-controlled research aircraft arrived at Dryden without their landing gear because funds had run out. The resourceful Dryden engineers simply bought a set of over-the-counter shock absorbers from the nearest Sears, Roebuck & Co. and mounted them as part of a jerry-rigged gear setup.

To make sure that the real plane would be cushioned on landing, the engineers first fitted the gear to a specially-built sled matching the weight of a HiMAT. The sled was hauled at high speed across the dry lake on the back of a flatbed truck and pushed off, bouncing to a stop undamaged. The calculations obviously were correct since the unpiloted planes went on to prove several advanced aircraft systems in a very successful research program from 1979 to 1984.

When NASA needed a carrier for its Long Duration Exposure Facility (LDEF), a school-bus-size satellite that exposed 57 experiments to space for nearly 6 years, it talked to several firms about building a custom unit. Fruehauf Trailer Corporation, Southfield, Mich., had a cost-effective solution -- just splice two of its truck trailers to form a single transporter. The trailers were sent to Langley Research Center, where Fruehauf employees modified the units and welded them together. LDEF was assembled directly on the trailer, which later transported the satellite on the ground before its 1984 launch into space and after its 1990 retrieval from Earth orbit.

What's next for the agency and its innovative cadre of pilots and engineers? Stay tuned. Or to borrow again from the auto world: "NASA, Start your engines!"

- end -

NOTE TO EDITORS: A short 3/4" video illustrating some of these programs is available to media by calling 202/453-8594. Still photos also are available by calling 202/453-8375.

	B&W	Color
Olds Toronado carriage	92-HC-254	92-HC-255
LDEF trailer	92-H-292	92-HC-256
Pontiac Catalina	92-H-293	
Plymouth Fury	92-H-294	
Ford XL	92-H-295	

# NASA News

National Aeronautics and  
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For Release

Sue Richard  
Headquarters, Washington, D.C.  
(Phone: 202/453-8364)

May 22, 1992

RELEASE: 92-71

## LIVINGSTONE APPOINTED TO NEW NASA POSITION

NASA Administrator Daniel S. Goldin today announced the appointment of Bill Livingstone as Special Assistant to the Administrator for Communications.

"Bill Livingstone, who has worked with the media nationwide, brings to the agency a broad array of experience and talent," Goldin said. "He joins the new team at NASA, which is dedicated to making the agency faster, better, cheaper, without compromising safety."

For the past 7 years, Livingstone was Press Secretary for then U.S. Senator and now Governor Pete Wilson (R-Calif.). Previously Livingstone was Press Secretary for U.S. Senator Jim McClure (R-Idaho). He also was the Press Secretary for Wilson's gubernatorial election in 1990, and McClure's re-election in 1984.

Livingstone was born in Helena, Mont. He received a B.S. from Montana State University (honors) and attended graduate school at the University of Southern California in motion picture production and the Fletcher School of Law & Diplomacy in international relations.

- end -

# NASA News

National Aeronautics and  
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For Release

Sue Mathis Richard  
Headquarters, Washington, D.C.  
(Phone: 202/453-8364)

May 26, 1992

RELEASE: 92-72

## **BROEDLING TO LEAD NEW CONTINUOUS IMPROVEMENT OFFICE**

NASA Administrator Daniel S. Goldin today announced the appointment of Laurie A. Broedling as Associate Administrator for Continuous Improvement. She will report directly to the Administrator and serve as NASA's primary facilitator of Total Quality Management. Broedling's appointment is effective tomorrow.

"This appointment is an important step in bringing a world-class TQM program to NASA," Administrator Goldin said. "Laurie Broedling has an outstanding background on facilitating TQM and is regarded as an expert in the field."

Broedling has had extensive experience leading the implementation of TQM in federal agencies. Before joining NASA, she served in the Department of Defense as Deputy Under Secretary for Total Quality, where she was responsible for overall direction of DoD's implementation of total quality principles and practices. From 1970 to 1989, she was employed by the Department of the Navy, where she held numerous managerial posts. These included serving as the Secretary of the Navy's TQM Technical Advisor, where she created the structure that institutionalized implementation of TQM across the entire Navy and Marine Corps.

Broedling also has been a professor at San Diego State University and George Washington University, where she taught graduate and undergraduate courses in strategic planning, organizational behavior and organizational development. She holds a B.A. in psychology from Brown University and an M.A. and Ph.D. in industrial-organizational psychology from George Washington University.

- end -

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
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For Release

**Michael Braukus**  
Headquarters, Washington, D.C.  
(Phone: 202/453-1549)

May 27, 1992

**Michael Mewhinney**  
Ames Research Center, Mountain View, Calif.  
(Phone: 415/604-3937)

RELEASE: 92-73

## **NASA/RUSSIANS COMPLETE ANTARCTIC EXPEDITION**

Three U.S. scientists, including one from NASA's Ames Research Center, Mountain View, Calif., recently completed the first joint U.S./Russian Antarctic expedition since the breakup of the former Soviet Union.

The purpose of the expedition was to investigate the physical, chemical and biological properties of ice-covered lakes in the Bunge Hills Oasis of East Antarctica. This was the first time U.S. scientists have explored these lakes near a Russian research station.

The scientists participated in the 37th Russian Antarctic Expedition. The U.S. participation in the expedition was sponsored by the Exobiology Implementation Team of the U.S.-Russian Joint Working Group for Space Biology and Medicine under the 1987 U.S.-U.S.S.R. Civil Space Agreement.

"This effort is part of a broader research program at Ames that includes research on microbes living in extreme environments. It also uses telepresence to explore these same environments," said Dr. Donald DeVincenzi of Ames, a team Co-chair. "Research in the Antarctic using telepresence is helping to define the technologies we will use during future missions to Mars."

Telepresence allows a remotely operated robotic vehicle to become a researcher's eyes and hands. Wearing a video headset, the researcher's senses can be extended to remote locations through a camera mounted on a remotely-operated robotic vehicle. The researcher points the camera with head movement and steers the vehicle with a pair of joysticks or with body motion.

- more -

"We developed a very successful working relationship with the Russians," said Dale Andersen, a Lockheed Engineering and Science Co. employee and U.S. Field Team Leader. "We showed that we can work together in very remote and hostile environments while collecting a high degree of good science," added Andersen, who works at Ames.

The scientists traveled to and from Antarctica aboard the Russian ship Akademik Fedorov, a 16,200-ton icebreaker designed for research in polar latitudes. The team left Montevideo, Uruguay in November 1991 and returned to the United States this month.

Although NASA scientists have conducted research in the dry valleys near the main American base in Antarctica for more than 20 years, this is the first time they have had an opportunity for an in-depth look at these ice-covered lakes in the Bunger Hills Oasis. Anderson said robots and tethered human divers conducted underwater studies during the expedition.

Previous studies of ice-covered lakes in the McMurdo Dry Valleys on Ross Island south of New Zealand have shown the lakes' similarity to lakes that may have existed on Mars in the past. While at Bunger Hills, scientists also mapped the location of lakes that have long since dried up and studied the role of ice in the formation of shoreline features. Similar features will provide clues to the location of ancient lakes on Mars.

Scientists studied the temperature, chemical composition and gas content of the water in the lakes. Andersen said the data collected is useful in the study of factors controlling lake formation and ice-cover development, gas dynamics within the water column and sediments, sediment formation and the preservation of biological samples in sediments.

During the expedition, scientists continuously collected meteorological data and sent it by satellite to Ames using a solar battery-powered transmitter. The transmitter will continue sending data for the indefinite future, providing the first long-term, year-round data base for this region of the world. "We also had a direct electronic mail link between Antarctica and our colleagues at Ames," Andersen said.

The Principal Investigator for the expedition was Dr. Robert Wharton of the Desert Research Institute at the University of Nevada. Dr. Christopher McKay of Ames is a Co-investigator. Joining Andersen on the expedition were graduate students Jim Rice from Arizona State University and Peter Doran from the Desert Research Institute at the University of Nevada.

- 3 -

Three Russian exobiology researchers -- Dr. Valeri Galchenko and Dr. Nikolai Chernekh of the Institute of Microbiology at the Russian Academy of Science and Dr. Dimitri Bolshiyarov of the Arctic and Antarctic Research Institute in St. Petersburg -- also were part of the expedition.

A team will travel to Antarctica again this fall to continue the research begun at Bunger Hills Oasis. U.S. participation in the expedition was funded by the Exobiology Program of NASA's Office of Space Science and Applications, Washington, D.C. Additional funding was provided by the Institute of Microbiology of the Russian Academy of Sciences.

- end -

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400



For Release

Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

May 27, 1992

Jean W. Clough  
Langley Research Center, Langley, Va.  
(Phone: 804/864-6122)

RELEASE: 92-74

## **NASA TO LEAD STUDY ON CLOUDS' EFFECT ON CLIMATE**

Nearly 300 atmospheric researchers will convene to study the effect of clouds on global climate in an international cooperative experiment, June 1-28. With NASA as the coordinating agency, scientists from over 50 research institutions in the United States and seven other countries will employ the combined measurements from land, sea, air and space platforms. The project will be based in the Azores and Madeira Islands of the eastern Atlantic Ocean.

The Atlantic Stratocumulus Transition Experiment (ASTEX) will study the puffy, layered clouds of the region to assess their physical and radiative characteristics and their effect on the atmosphere and ocean. The analysis will help refine the predictive computer models used to anticipate world-wide weather patterns.

The concept of operations is wide-ranging. Instruments will make atmospheric measurements from two islands while five instrumented ships will make atmospheric and oceanographic measurements. Buoys will collect oceanographic and surface measurements and seven aircraft from three nations will fly atmospheric missions. These measurement efforts will be coordinated with the overflights of eight cloud-measuring satellites.

The experiment, managed by NASA's Langley Research Center, Hampton, Va., includes scientists from NASA's Goddard Space Flight Center, Greenbelt, Md., and Ames Research Center, Mountain View, Calif., and representatives of the Office of Naval Research, the National Science Foundation, the Department of Energy, the National Oceanographic and Atmospheric Administration and 12 U.S. universities. Independent contributions will be made by agencies from the United Kingdom, France, Germany, Russia, the Netherlands and Portugal.

- more -

- 2 -

ASTEX is a key component of the U.S. national contribution to the World Climate Radiation Program of the World Meteorological Organization. The ASTEX project manager is Langley's David S. McDougal. Dr. Bruce Albrecht, Department of Meteorology, Pennsylvania State University, is the ASTEX lead scientist.

- end -

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For Release

Sue Mathis Richard  
Headquarters, Washington, D.C.  
(Phone: 202/453-8364)

May 27, 1992

RELEASE: 92-75

## **"OSCAR" RETURNS FROM SPACE TO THE ACADEMY**

After travelling nearly 4 million miles in space aboard the Space Shuttle Atlantis, "Oscar" returned home to the Academy of Motion Picture Arts and Science (AMPAS). Today, NASA Administrator Daniel S. Goldin and Col. Charles Bolden, Commander of the Atlantis mission, along with crew members Brian Duffy and David Leestma presented the space-faring statuette to Karl Malden, President of AMPAS.

The ceremony took place in the Bob Hope Lobby of the Academy's Center for Motion Picture Study in Beverly Hills. Also participating in today's "return of Oscar from space" ceremony was Gil Cates, producer of the past three Oscar telecasts. "Perhaps no other contemporary filmmaker's name is so synonymous with movies about space than George Lucas' -- with the possible exception of Steven Spielberg, who presented the award to George," Cates said. "And because of that association with space exploration, it was natural to tie in our nation's space program with the presentation. Taking the Oscar into space was the perfect way to do it."

"We don't go around letting Oscar take trips with just anyone, you know," Malden commented wryly, "but when Gil came to me with this idea, I felt confident that our Academy's symbol would be in good hands."

On March 30, the Space Shuttle crew aboard Atlantis, along with a free-floating passenger named Oscar, participated in the 64th Annual Academy Awards festivities. After Steven Spielberg presented the Irving G. Thalberg Award to George Lucas, the world watched a videotaped salute to Lucas by the orbiting crew who hailed him as "an explorer in his own right." Commander Bolden praised Lucas by saying, "The imagination and ingenuity that have turned dreams into the reality of space flight are no different than those which turn ideas and inspiration into motion pictures." Lucas received the Thalberg Award from the Academy for his high standards of film production.

- more -

Enhancing the space theme of today's event were enlargements of photos from the Center's Photographic Stills Archive depicting scenes of landmark motion pictures dealing with space, including shots from one of the earliest of all films, Melies' "Journey to the Moon;" "Destination Moon;" "2001: A Space Odyssey;" and Lucas' own landmark film, "Star Wars." Also displayed was a photo of the Space Shuttle Atlantis launch on mission STS-45.

During Lucas' March 30 acceptance speech at the Academy Awards he thanked his parents and teachers for their inspiration and credited them with teaching him everything he knows. He went on to say that filmmakers are teachers too, only they have louder voices and reach larger audiences.

To show the motion picture industry one way in which NASA reaches students and teachers across America, NASA's first tractor-trailer-mounted, mobile teacher resource center was parked outside the Academy offering tours and educational demonstrations.

LASER (Learning About Science, Engineering and Research) is outfitted with six teacher work stations where teachers can access NASA information and education materials from computers, view and copy NASA-produced videos, duplicate slides, and reproduce lesson plans and activities. The 22-ton mobile center is staffed by a full-time specially selected mathematics and science teacher and two technicians.



For Release

Mark Hess  
Headquarters, Washington, D.C.  
(Phone: 202/453-4164)

May 28, 1992

Elaine Hinsdale  
Space Station, Reston, Va.  
(Phone: 703/438-5157)

NOTE TO EDITORS N92-47

## **SPACE STATION FREEDOM EXHIBIT KICKS OFF TOUR IN WASHINGTON, D.C.**

NASA will kick-off a nationwide tour of its full-scale traveling Space Station Freedom model in the Washington, D.C., metropolitan area next week. The model, which is housed in two connected tractor trailers, features the U.S. living quarters and the U.S. laboratory module of the international space-based research facility.

Visitors can walk through this model and find out what it would be like aboard the facility where the astronauts will live and work for months at a time. Astronauts will start living and working aboard the U.S. laboratory in late 1996.

Inside the habitation module, which fills most of one tractor trailer, visitors will learn about the challenges engineers face in designing Freedom. Take, for example, the waste management system, or bathroom. A full-scale design of the bathroom is on display in the Habitation Module mockup.

In space, there is no up or down orientation as on Earth. That means all areas of the Space Station will be usable. The Freedom exhibit illustrates this with equipment racks in the floor and ceiling, as well as along the side walls. On board the real Space Station Freedom, sophisticated systems will make the space station an almost self-contained environment, relying exclusively on solar power to generate electricity.

## **SPACE STATION FREEDOM EXHIBIT DATES AND LOCATIONS:** (ALL TIMES EDT)

June 2-4	9:30 A.M.-6 P.M.	East front parking lot of the Capitol building
June 6-8	10 A.M.-5 P.M.	10701 Parkridge Blvd., Parking Lot, Reston, Va.
June 9-12	10 A.M.-6 P.M.	on Constitution Avenue by the American History Museum

- end -



For Release

Paula Cleggett-Haleim  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

May 28, 1992

Jim Elliott  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-6256)

NOTE TO EDITORS: N92-48

## **NASA TO BRIEF MEDIA ON NEW HST IMAGES OF COLLIDING GALAXIES**

Dramatic, new Hubble Space Telescope images of a distant galaxy undergoing one of the largest "starbursts" on record will be the subject of a media briefing scheduled for Tuesday, June 2, at 11:00 a.m. EDT in the NASA auditorium, 400 Maryland Ave. S.W., Washington, D.C.

A starburst represents the simultaneous creation of a large number of stars as the result of a major event, such as the collision or merger of two galaxies. Astronomers have never before seen a "starburst galaxy" in such detail as in these new HST images.

A panel of distinguished astronomers will discuss the significance of these images and explore the possibility that the findings have resolved a mystery raised 9 years ago, when NASA's Infra-Red Astronomy Satellite discovered the new class of "ultraluminous infrared galaxies."

Announcing the new findings will be Dr. Edward Shaya, University of Maryland at College Park. Guest panelist and authority on infrared astronomy, Dr. Carol Lonsdale, California Institute of Technology, Pasadena, Calif., who will join regular panelists Profs. Bruce Margon, University of Washington, Seattle; Daniel Weedman, Pennsylvania State University, University Park; and host Dr. Steve Maran, Senior Staff Scientist, Goddard Space Flight Center, Greenbelt, Md.

- end -



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For Release

Paula Cleggett-Haleim  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

May 28, 1992

Jim Doyle  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 92-76

## **LARGE LANDSLIDES FOUND ON VENUS**

Large landslides have been identified on Venus by Magellan Project scientists at NASA's Jet Propulsion Laboratory, Pasadena, Calif. They are similar to landslides that have been known for some time to occur on Earth and Mars, a project spokesperson said.

Four images, being released today, show evidence of the landslide process. One image clearly shows rubble beneath a cliff.

Project Scientist Dr. Steve Saunders said the large landslides could occur on Venus about as frequently as they do on Earth, about once a year, but they usually are larger than terrestrial slides, he said.

Landslides occur on steep slopes that have formed by faults and on the slopes of volcanoes and generally are triggered by seismic activity or quakes.

The most dramatic landslides on Venus are seen beneath the slopes of volcanoes and may have formed much like the Mount St. Helens eruption in Washington state in 1980, Saunders said.

"The Mount St. Helens eruption is an example of the formation of an avalanche caldera where a large portion of the volcano collapsed and flowed downslope," he said, "but the avalanche calderas on Venus are much larger."

The larger landslides on Venus spread 18 miles across the surface. Most Venusian landslides have a rough, hummocky appearance that is typical of all landslides, he said. They are made of a jumble of rock fragments of all sizes that broke up during the violent downhill journey in the few minutes it takes to form the slides.

- more -

- 2 -

Saunders said the size of a landslide depends on the height of the slope from which it comes and the longest landslides come from the highest slopes.

The longest known landslides are found on Earth. Undersea slides reach more than 200 miles in length. Martian landslides are next in size, with lengths of 60 miles and more. The largest Venusian landslides extend only about 30 miles.

Since erosion rates on Venus are so low due to the lack of water on the surface, landslides are an important mechanism in wearing down mountain regions on Venus. The rounded hills of the complexly deformed tessera, or tile-like, terrain on Venus have probably been modified by numerous landslides, he said.

Magellan has mapped more than 97 percent of the planet, with about 35 percent of the surface imaged in both right and left-look modes and about 20 percent imaged in stereo using different look angles.

JPL manages the Magellan Project for NASA's Office of Space Science and Applications.

- end -

NOTE TO EDITORS: Magellan images are available to news media representatives through NASA's Broadcast and Imaging Branch on 202/453-8375. The photo numbers for images depicting this landslide activity are: 92-H-364, 92-H-365, 92-H-366 and 92-H-367.



For Release

Mark Hess  
Headquarters, Washington, D.C.  
(Phone: 202/453-4164)

May 29, 1992

Jeffrey Carr/Barbara Schwartz  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 92-77

## **ASTRONAUT BUCHLI TO RETIRE AND LEAVE NASA**

Astronaut James F. Buchli (Col., USMC) will retire from the U.S. Marine Corps and leave NASA in August to accept the position of Manager, Station Systems Operations and Requirements with Boeing Defense and Space Group, Huntsville, Ala.

Buchli is a veteran of four Space Shuttle missions: STS-51C, a Department of Defense flight in January 1985; STS-61A, the West German Spacelab D 1 mission in November 1985; STS-29, a mission to deploy a Tracking and Data Relay Satellite in March 1989; and STS-48 in September 1991 on which the Upper Atmosphere Research Satellite was deployed.

Buchli also has served as Deputy Chief of the Astronaut Office since March 1989. Since becoming an astronaut in August 1979, Buchli has held a number of technical assignments, including spacecraft communicator in Mission Control and in the Astronaut Office Operations Development Branch working on controls and displays for the Shuttle and Space Station Freedom.

"I'm grateful for my years of active service as a Marine and as part of the NASA team. It has allowed me to be a part of two of the finest organizations in the world. I'm looking forward to changing career directions and remaining involved with the outstanding people who make up our space team," Buchli said.

"Jim has made significant contributions to the Astronaut Office and to the space flight program during his tenure here. We'll miss him and wish him continued success. His experience on four Space Shuttle flights and his managerial abilities will be assets to Boeing in their Space Station Freedom efforts," Donald R. Puddy, Director of Flight Crew Operations, said.

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# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400



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For Release

Terri Sindelar  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

May 29, 1992

Cecelia Blalock  
Young Astronaut Council, Washington, D.C.  
(Phone: 202/682-1984)

RELEASE: 92-78

## **OUTER SIGHT STUDENT ART CONTEST WINNERS SELECTED**

NASA and the Young Astronaut Council today announced the 12 winners of the International Space Year 1992 (ISY) student space art contest, **Outer Sight**. Over 1,800 school children in grades K through 9 entered the competition to capture ISY's spirit of world-wide celebration of space cooperation and discovery by expressing their vision of future space exploration and discovery.

The overall winner of the competition is second grader and home-schooler Jonathan Hester from Wilson, N.C. Jonathan's design depicts young astronauts from around the world holding hands in space. He will receive an all-expense paid trip to the 1992 Young Astronaut Council ISY Educators' Conference, which will be held Oct. 8-12, in Orlando, Fla. His winning poster will be introduced at the opening ceremonies of the conference which more than 1,500 teachers and students are expected to attend.

The other eleven winners and their designated grade categories are as follows:

Grade category K-3: *Emily Lauter*, grade 3, Lincoln Elementary, Brainerd, Minn.; *Andrea Noe*, grade 2, Hawes Elementary, Ridgewood, N.J.; and a collaborative effort from *Amanda Nolan*, *Lauren Machen*, *Brandon Ferronto* and *Elizabeth Kitsch*, grade 3, Weymouth Township School, Dorothy, N.J.

- more -

Grade category 4-6: *Samantha Aigner*, grade 4, McClellan School, Pittsburgh, Penn.; *Teri Terrell*, grade 5, Windy Hill Elementary, Jacksonville, Fla.; *Brennan Maupin*, grade 6, Harencroft Elementary, Olathe, Kan.; and *Heather Scor*, grade 4, Lakeland School, Syracuse, N.Y.

Grade category 7-9: *John Kulluck*, grade 8, LaCanada High School, LaCanada, Calif.; *David Kowalski*, grade 7, Derby Intermediate School, Derby, Conn.; *Chris Miller*, grade 9, Saint Xavier High School, Louisville, Ky.; and *Catherine Carter*, grade 9, Garrison Forest School, Long Green, Md.

Each winner will receive a certificate and trophy in honor of their accomplishment.

The ***Outer Sight*** art contest was officially announced by President Bush on Jan. 24, 1992 at a White House event to kick-off the International Space Year.

Judges met May 27 to select the top winning designs. The panel included Astronaut and NASA Assistant Deputy Administrator Charles Bolden; NASA's Director of Fine Arts and Graphics, Bob Schulman; NASA's Education Program Manager Muriel Thorne; former Curator of Art at the National Air and Space Museum, James Dean; artist Ron Miller, and Young Astronaut Council President T. Wendell Butler.

"The students demonstrated a wide array of creativity," states Bob Schulman, "I was impressed by the individuality and uniqueness of each of the twelve winners. I congratulate and applaud their outstanding accomplishments."

T. Wendell Butler adds, "Children are natural artists, and space travel began in the imagination of artists. It's a natural logical thing to take a subject like this and explore it through visual media."

The top winning design is on display at the NASA Headquarters Auditorium located on the sixth floor at 400 Maryland Ave. S.W., Washington, D.C., and will be available for viewing May 30 through June 5.

All twelve winning posters will be displayed at the Smithsonian's Air and Space Museum later in the year.

- end -

EDITORS NOTE: A photograph of the winning design is available to media representatives by calling NASA Headquarters Audio/Imaging Branch on 202/453-8375.

Color: 92-HC-346

B&W: 92-H-392



For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/453-1549)

EMBARGOED UNTIL  
10:30 a.m. May 30, 1992

Kari Fluegel  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 92-79

## **DNA FINGERPRINTING USED TO TRACK MICROBES IN SPACE**

Advanced techniques used to place criminals at crime scenes now are being employed in NASA's continuing investigation of microbial activity in the weightless environment of orbiting spacecraft.

Since the Apollo program, medical researchers have investigated the possibility of microbial cross-contamination between astronauts confined to a spacecraft. The advent of recent methods such as DNA fingerprinting, which studies organisms at the molecular level, has allowed scientists to track the transfer of a specific microbe within the environment of the Space Shuttle orbiter, according to a joint study by NASA's Johnson Space Center (JSC), Krug Life Sciences, Houston and the University of Texas Medical School.

Results of the study, "Staphylococcus aureus on Earth and in Space," are being presented this week at the annual American Society for Microbiology meeting in New Orleans.

Staphylococcus aureus was chosen as the target organism for the development of the tracking method because it is a common microbe carried in the throat and nasal cavity of about 20-40 percent of normal, healthy humans. It is easily transferred to the air and other surfaces through actions as simple as sneezing.

Though the grape-like clusters of most Staphylococcus aureus colonies look identical, the DNA molecules within the microbe are unique and may allow a microbe to be traced to its original carrier. This technique is analogous to the use of DNA from a tissue or blood sample found at a crime scene to identify a criminal.

"We're exploiting the uniqueness of the individual at the most basic level," said Duane L. Pierson of JSC's Biomedical Research and Research Branch.

- more -

On a recent Shuttle mission, *Staphylococcus aureus* was isolated among several crew members during the microbial sampling portion of the routine pre- and post-flight physicals. Microbe samples also were collected from Shuttle surfaces including air vents, the galley and middeck lockers before, during and after the mission. DNA from the samples was extracted, cut into smaller fragments and analyzed using Pulsed Field Gel Electrophoresis which separates the fragments and generates a pattern unique to the organism in the sample.

Investigators did not detect any transfer of the organism between the crew members during the flight, however, *Staphylococcus aureus* isolated in samples from the crew compartment was used to trace the specific microbes to their originators. The analysis also showed that the space flight did not alter the DNA profile of the *Staphylococcus aureus* strains.

DNA fingerprinting has been used by crime investigators since the late 1980s, but the team's study was the first use of the technique in the space program. Such use could allow more extensive research into the microbial environment of space vehicles.

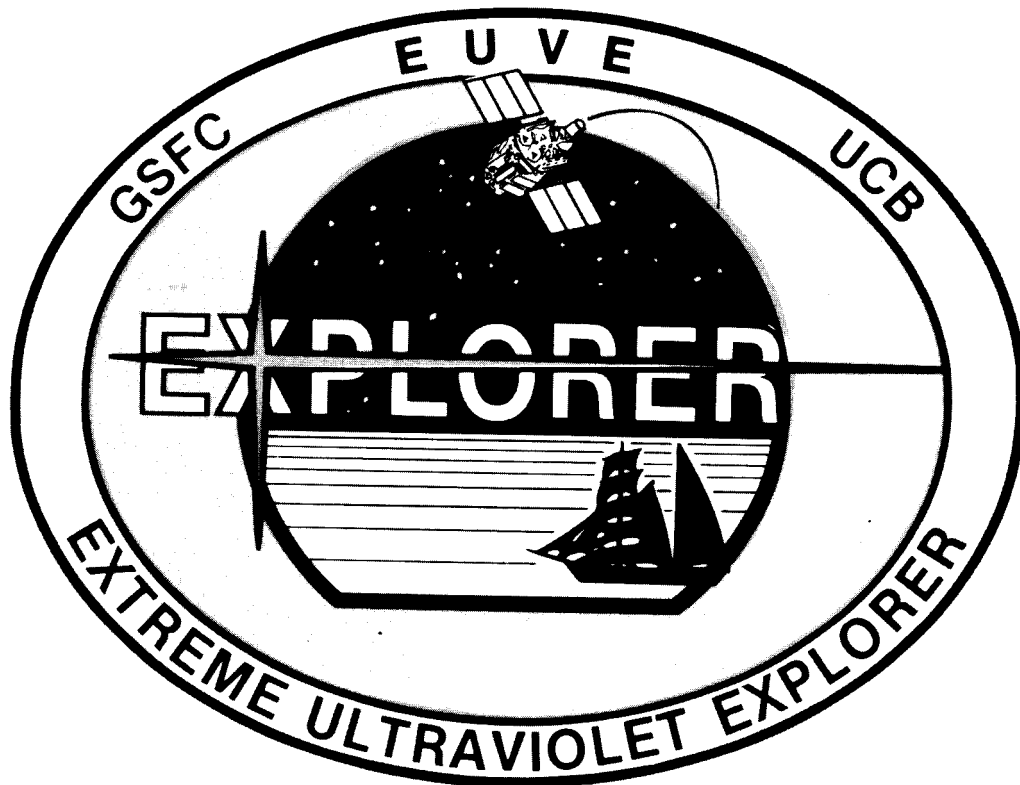
"This technique also has the potential to be another tool that would complement existing technology in forensic analysis," said George Weinstock, University of Texas Medical School.

Other investigators were Monjula Chidambaram and Joe Don Heath, University of Texas Medical School; Baldev Sharma, Houston Police Crime Lab; Laura Mallery and S. K. Mishra, Krug Life Sciences, Houston.



# EXTREME ULTRAVIOLET EXPLORER

## PRESS KIT



JUNE 1992

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## **PUBLIC AFFAIRS CONTACTS**

Michael Braukus  
Office of Space Science and Applications  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-1549)

Dolores Beasley  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-2806)

George Diller  
Kennedy Space Center, Fla.  
(Phone: 407/867-2468)

Camille Trentacoste  
University of California, Berkeley  
(Phone: 510/642-9319)

Capt. Kenneth Warren  
Public Affairs Office  
45th Space Wing  
Patrick Air Force Base, Fla.  
(Phone: 407/494-7731)

**GENERAL RELEASE**

Release: 92-XX

**EUVE SATELLITE TO EXPLORE NEWLY OPENED WINDOW**

The extreme ultraviolet is one of the least-studied portions of the electromagnetic spectrum. Now, with the launch of NASA's Extreme Ultraviolet Explorer (EUVE) satellite, this new window on the Universe will be opened to detailed study.

EUVE, NASA's 67th Explorer mission, will be the first satellite to make both spectroscopic and wide-band observations over the entire extreme ultraviolet (EUV) region. It is scheduled for launch aboard a McDonnell Douglas Delta II expendable launch vehicle from Cape Canaveral Air Force Station, Fla., on June 4, 1992. EUVE is designed to operate for at least 18 months from a 340-mile (550km) Earth orbit and will orbit the Earth every 96 minutes.

This unique satellite consists of four telescopes--the most powerful set of EUV telescopes ever flown. Three of these instruments will map the entire sky to determine the existence, direction, brightness and temperature of sources of extreme ultraviolet radiation. The fourth instrument is designed to make spectroscopic observations to determine the composition and temperature of the EUV sources discovered during the sky mapping. Some of the objects EUVE is likely to detect and study are white dwarf stars, binary star systems and the hot outer atmospheres (coronae) of stars similar to our Sun.

From the many objects of astronomical interest discovered during the EUVE all-sky survey and other objects already thought to be observable in the extreme ultraviolet, guest observers will propose to study targets using the spacecraft's fourth instrument, the extreme ultraviolet spectrometer.

The EUVE is one of a long line of relatively low-cost, small-to-moderately sized missions that make up the Explorer program. Since the Explorer Program began in 1958, these missions have given scientists worldwide a new understanding of astronomy and astrophysics, providing them an opportunity to probe nearly every region of the electromagnetic spectrum, from infrared radiation to gamma rays.

Goddard Space Flight Center, Greenbelt, Md., is responsible for the design, construction, integration, checkout and operation of EUVE. The spacecraft's science instrumentation was designed, constructed and calibrated by the Space Science Laboratories of the University of California, Berkeley. The EUVE is managed by Goddard for NASA's Office of Space Science and Applications.

- end -

## SCIENCE OBJECTIVES

Astronomers use the term "extreme ultraviolet" (EUV) to refer to the high-energy end of the ultraviolet portion of the electromagnetic spectrum. Like other forms of light such as infrared and X-rays, EUV light is blocked by the Earth's atmosphere. It must be studied from space. In fact, even the very low density gas found between the stars can block EUV light. Initially astronomers thought it would be impossible to detect EUV rays from sources beyond our solar system.

However, our Sun is now known to lie within an unusually hot transparent region of interstellar space. This region, about 250 light-years in diameter, is often called the local bubble. Apart from a few small wisps of cold, opaque gas, it is mostly transparent to EUV radiation. EUV light from very distant stars beyond the local bubble is unlikely to reach the Earth's vicinity, and thus EUVE will mostly detect sources in our own stellar neighborhood.

The scientific mission of EUVE will initially consist of a six-month all-sky survey, together with a highly sensitive "deep" survey of a limited portion of the sky. This will then be followed by a spectroscopy phase of at least one year. In the spectroscopy phase, individual targets, whether discovered in the all-sky survey or identified from other information, will be analyzed in detail through selected observations made with an on-board extreme ultraviolet spectrometer.

The EUVE surveys will be conducted by astronomers from the Center for Extreme Ultraviolet Astrophysics (CEA) at the University of California, Berkeley, while the spectroscopic studies will be performed by guest observers, selected through peer review.

As in the case of earlier Explorer missions, the most exciting discoveries may be those that are unexpected. Objects thought to be well understood may display surprising properties at extreme ultraviolet wavelengths, and it is even conceivable that entirely new classes of celestial objects may be discovered.

**RESPONSIBILITIES**

Observatory	Goddard Space Flight Center
Telescopes	Center for EUV Astrophysics, University of California, Berkeley
Explorer Platform Spacecraft	Fairchild Space, Germantown, Md.
Delta II Launch Vehicle	McDonnell Douglas, U.S. Air Force and NASA

# MISSION TIMELINE

Event	Time (Min:Sec)	Altitude (St.Miles)	Velocity (MPH)
Liftoff	0:0	0	0
Six solid rocket motors jettison	1:02	8.75 14.08 km	1,929 3,104.3 kmh
Three solid rocket motors jettison	2:02	27.14 43.6 km	4,492 7,228.9 kmh
Main engine cutoff	4:24.5	64.05 103.07 km	12,682 20,409.1 kmh
Second stage ignition	4:38	69.3 111.5 km	12,680 20,405.9 kmh
Fairing release	5:05	78.5 126.3 km	12,855 20,687.5 kmh
Second stage engine cutoff	11:11.9	110.17 177.3 km	17,699.9 28,484.5 kmh
Second stage restart	66:53	328.83 529.2 km	16,791.7 27,022.8 kmh
Second stage engine cutoff (2)	67:12	328.22 528.2 km	16,994.4 27,349.08 kmh
Spacecraft separation	71:05	327.99 527.83 km	16,995.3 27,350.53 kmh

## THE INSTRUMENTS

EUVE contains four telescopes, each 40 centimeters across. The three scanner telescopes and the deep survey/spectrometer telescope represent the state-of-the-art in extreme ultraviolet technology. These instruments, developed by scientists and engineers at the University of California, Berkeley, are mounted in the payload module, which is installed as a unit on the Explorer Platform spacecraft. The spacecraft was designed and built by Fairchild Space in Germantown, Md., under Goddard management.

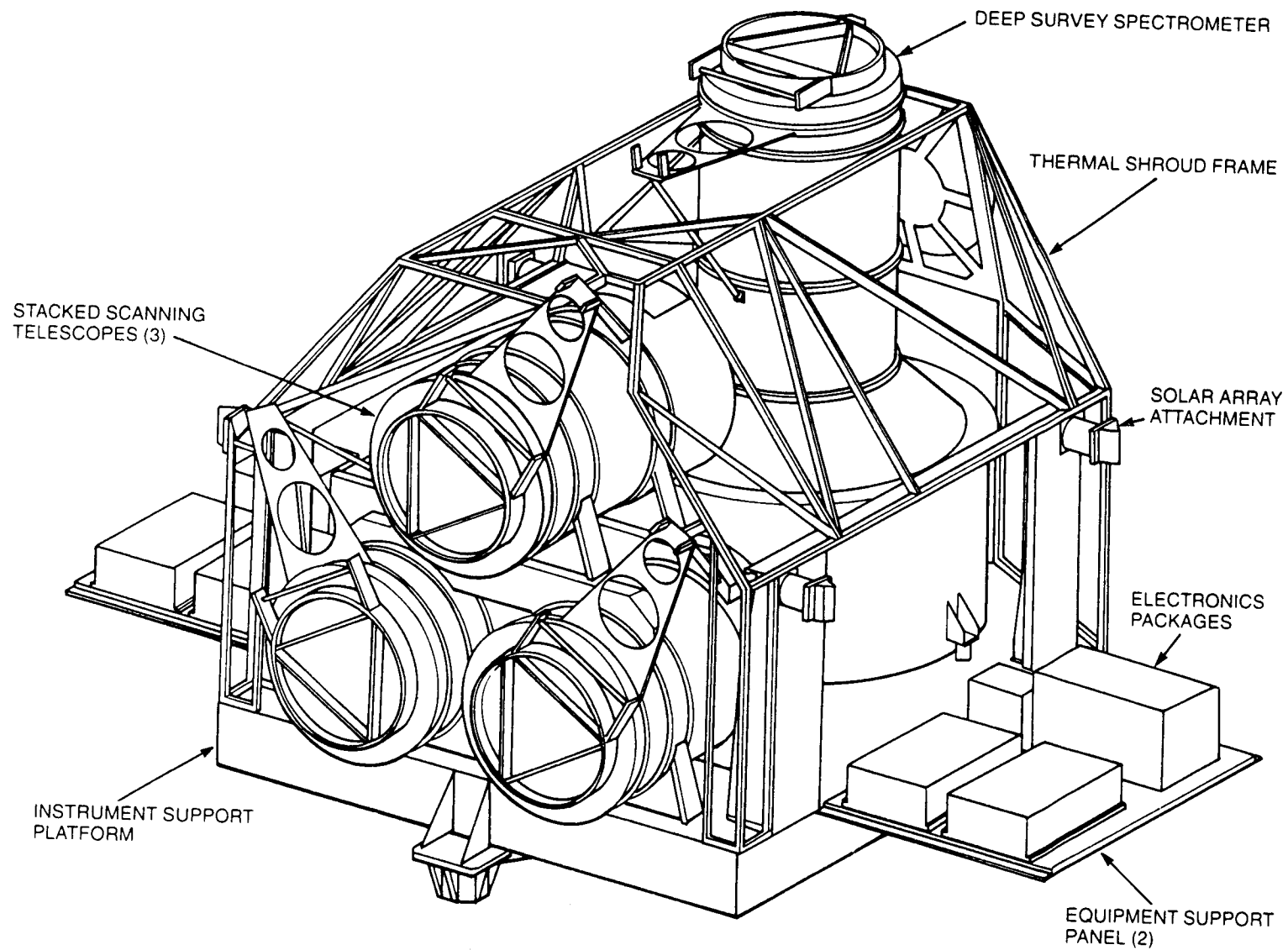
Each of the EUVE scanner telescopes is about as large as a 55-gallon oil drum and weighs about 260 pounds (about 188 kilograms). The deep survey telescope/spectrometer weighs about 710 pounds (323 kilograms).

Two of the scanning telescopes are nearly identical to verify observations and to ensure a backup capability in the event of a malfunction. They are used for observing at the high-energy end of the extreme ultraviolet spectral band (70-400 Angstroms) --the energy range within which most sources are expected to be detected. These telescopes have gold-plated mirrors, with very small grazing angles to reflect the maximum amount of radiation at these higher energies.

The third scanner is specially designed to observe at the low-energy end of the extreme ultraviolet spectral band (400-760 Angstroms). Its mirrors are plated with a special nickel alloy and use larger grazing angles to reflect the maximum amount of lower energy radiation.

The Deep Survey/Spectrometer telescope's opening, or aperture, is divided into six equal segments. Radiation from three of these segments is focused by the grazing-incidence mirror onto the single deep-survey detector. During the survey phase, this telescope will make long-exposure observations while being pointed down the dark shadow cast by the Earth, allowing it to detect much fainter sources than the all-sky survey scanners.

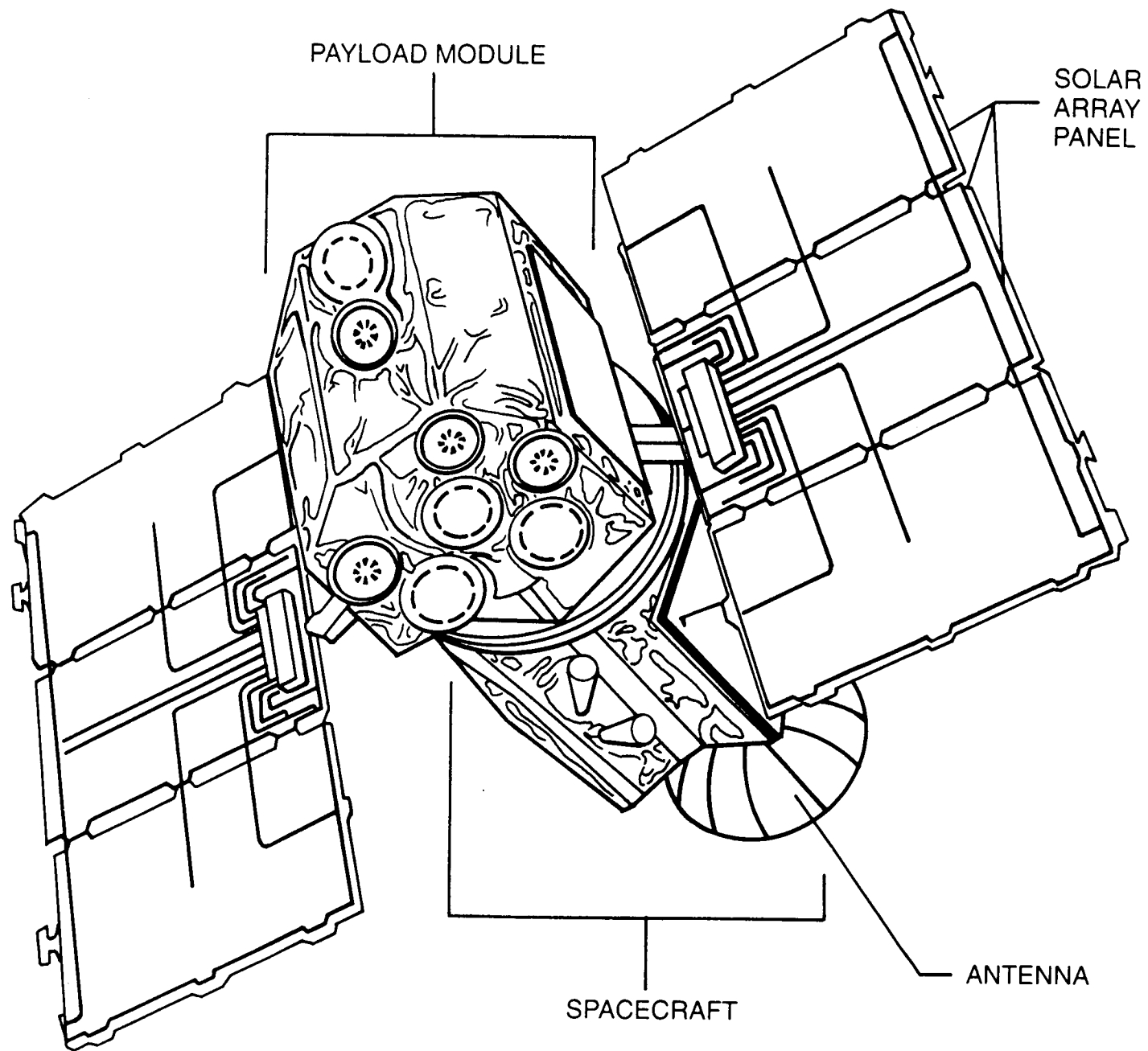
Radiation from the other three mirror segments is intercepted by diffraction gratings that spread the radiation into beams of different energy. The beams are then directed to the spectrometer's three detectors. During spectroscopy studies, the spectrometer will analyze the wavelength distribution of radiation from individual sources to determine their temperature and chemical composition.



## SPACECRAFT OPERATIONS

The Explorer platform spacecraft, plus the science payload, comprise the Extreme Ultraviolet Explorer observatory. The observatory is thermally controlled to protect the science payload from extreme temperature changes. This protection is especially important because orbital night and day occur about 16 times each Earth day as the satellite circles the planet.

Like most satellites, the Extreme Ultraviolet Explorer is solar powered. Photovoltaic cells on the satellite's solar array panels convert solar energy into electricity, which is stored in rechargeable batteries. At the beginning of the mission, the arrays will provide the spacecraft with more than 1,000 watts of power during its journey around Earth. Three hundred watts will be allotted to power the science payload -- one-fourth the power needed to operate a typical microwave oven.



## MISSION OPERATIONS

During the mission, Goddard's Payload Operations Control Center (POCC) will be responsible for communications with the observatory, transmitting commands and receiving science and engineering data. The center will then route all science-related information to the University of California, Berkeley.

NASA's Tracking and Data Relay Satellite System (TDRSS) plays an integral role in mission communications. The observatory first transmits data to a relay satellite, located 22,300 miles above the Earth in geostationary orbit, which sends the information to the TDRSS ground station at White Sands, NM. From there, the data are relayed up to a commercial communications satellite, also in geostationary orbit, and down to Goddard. Finally, the scientific data are sent over telephone lines to Berkeley.

## SCIENCE OPERATIONS

While the Goddard Space Flight Center controls mission operations, the Center for Extreme Ultraviolet Astrophysics (CEA) will coordinate science operations, monitor instrument performance and collect data.

CEA, which operates from a dedicated building near the Berkeley campus, includes a Science Operations Center and a Science Data Analysis Facility. The Science Operations Center will work closely with Goddard mission planners to coordinate the acquisition of scientific measurements and command the instruments. The satellite's raw science telemetry and processed data will be archived at the Science Data Analysis Facility. There, Berkeley scientists will produce the all-sky survey catalog and sky map and study data from the mission's deep survey.

In addition, Berkeley will support the NASA-sponsored Guest Observer Program during the mission's spectroscopy phase. One of Berkeley's tasks will be scheduling spectroscopic observations for the Guest Observers, who can interpret data either at their home institutions or at the Berkeley facility.

## **PAYLOAD PROCESSING**

The Extreme Ultraviolet Explorer flight elements arrived at Hangar AE on Cape Canveral Air Force Station (CCAFS) at the end of January. The Payload Module was flown into the CCAFS Skid Strip by an Air Force C-5 aircraft on Jan. 27, 1992 and the Explorer Platform was delivered by truck on Jan. 28. Processing was accomplished in Hangar AE, a NASA facility on CCAFS by the Goddard Space Flight Center's EUVE NASA/contractor team with support from the Kennedy Space Center's Payload Operations Directorate. After initial checkout, the Explorer Platform was mated with the science payload module on Feb. 24.

A milestone was reached on March 6 when the first "Countdown plus early orbit" mission simulation was successfully completed. This exercise began at a simulated Launch minus 18-hours and continued through Launch plus 48 hours. A second simulation was successfully completed on April 21.

After achieving a simulated orbit, the EUVE Payload Operations Control Center (OCC) at Goddard and the EUVE Science Operations Center (ESOC), located at the University of California, Berkeley, sent simulated commands to the spacecraft. The spacecraft was to be moved to the launch pad in mid-May for mating and integration with the Delta II launch vehicle.

## LAUNCH OPERATIONS

The U. S. Air Force's 1st Space Launch Squadron, 45th Operations Group, 45th Space Wing, is responsible for the preparation and launch of the Delta II which will carry the Extreme Ultraviolet Explorer into orbit.

The Delta II underwent buildup on Pad A of Space Launch Complex 17 at CCAFS in mid-April. This activity includes erecting the first stage and interstage, mating the nine solid rocket boosters in place around its base, and then hoisting the second stage atop the first stage. The significant mechanical and electrical tests are scheduled to run between May 10 and May 20.

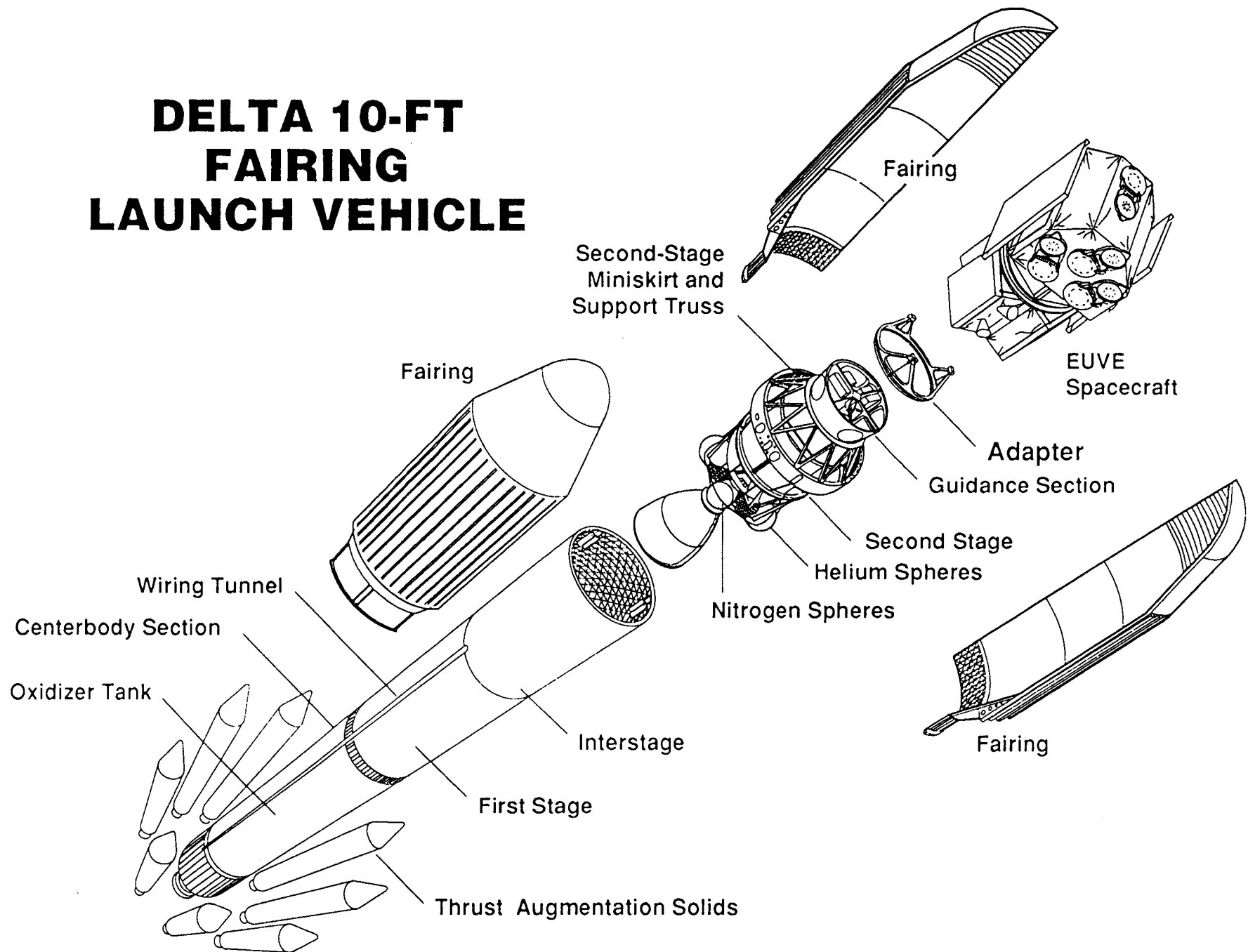
On approximately May 15, the EUVE spacecraft is scheduled to arrive at the pad to be mated to the Delta second stage. EUVE's integrated checks atop the vehicle and final spacecraft functional tests were planned to run between May 20 and May 24. During this period, workers will install the nose fairing around the spacecraft.

The hypergolic propellants will be loaded aboard the Delta second stage approximately two days prior to launch. The RP-1 fuel (kerosene propellant) and the super cold liquid oxygen, used as an oxidizer by the first stage, will both be loaded aboard during the terminal countdown.

Launch operations will be conducted from the Complex 17 blockhouse by a joint USAF/McDonnell Douglas team under the direction of the 45th Operations Group.

As this mission involves launch of a NASA payload, the space agency has responsibility for supporting EUVE flight preparations. A NASA KSC launch manager will represent all space agency interests during vehicle preparations and the launch countdown and serve as NASA liaison with the Air Force. The launch manager will be located in the Mission Director's Center at CCAFS to monitor launch countdown operations and to provide the final NASA concurrence for launch to the USAF launch director.

# DELTA 10-FT FAIRING LAUNCH VEHICLE



## LAUNCH VEHICLE

A U. S. Air Force Delta II 6920-10 expendable launch vehicle will lift the EUVE into low-Earth orbit for NASA. Built by McDonnell Douglas Space Systems Company (MDSSC) of Huntington Beach, Calif., the Delta II has a perfect launch record.

The EUVE flight will be the second time a 10-foot (3 meters) diameter fairing has been used on a Delta vehicle. Its first use was in 1990 for launch of the Roentgen Satellite (ROSAT) mission. The fairing, built in three sections, is based on the Titan family of fairings MCSSC has built for years.

NASA funded the development of the 10-foot fairing to accommodate the ROSAT, EUVE and other payloads requiring a larger volume than offered by the 9.5-foot and 8-foot (2.8 meters and 2.3 meters) fairings regularly flown on Delta.

The EUVE launch is scheduled to be the 24th flight for the Delta II. Delta's origins reach back to the mid-1950s when the U. S. Air Force developed the Thor intermediate-range ballistic missile. NASA later modified the Thor, a single-stage, liquid-fueled missile for the Delta launch vehicle.

The two-stage Delta II carrying EUVE consists of four major assemblies, the first stage, including nine strap-on solid rocket motors, the interstage, the second stage and the payload fairing.

The Delta II is 123.4 feet tall and 8 feet (37.4 meters and 2.3 meters) in diameter. The payload fairing is 26 feet tall and 10 feet (7.8 meters and 3 meters) in diameter. The first stage main engine has a liftoff thrust of 207,000 pounds (93,150 kilograms) and each of the nine solid strap-on motors has a sea-level thrust of 97,070 pounds (43,681 kilograms). The main engine and six of the nine solid motors are burning at liftoff, providing a total thrust of 789,420 pounds (355,239 kilograms).

The second set of three solid strap-on motors is ignited during the first stage burn. The second stage engine has a vacuum-rated thrust level of 9,645 pounds (4,340 kilograms).

Several major subcontractors to MDSSC contributed to the Delta vehicle. The Rocketdyne Division of Rockwell, Canoga Park, Calif., is responsible for the first stage engine. Aerojet TechSystems Co. of Sacramento, Calif., builds the second stage engine. Morton Thiokol of Huntsville, Ala., manufactures the solid rocket boosters and Delta Systems of Goleta, Calif., produces the guidance computer.

## **MISSION MANAGEMENT**

### **NASA Headquarters:**

Dr. Lennard A. Fisk, Associate Administrator, Office of Space Science and Applications  
Dr. Charles J. Pellerin, Jr., Director, Astrophysics Division  
John Lintott, Program Manager  
Dr. Robert Stachnik, Program Scientist  
Charles Gunn, Director, Expendable Launch Vehicle and Upper Stages Office

### **Goddard Space Flight Center:**

Dr. John Klineberg, Center Director  
James Barrowman, Project Manager, Explorers and Attached Payloads  
Frank Volpe, Associate Project Manager for EUVE  
Dr. Yoji Kondo, Project Scientist  
Pete O'Neill, Project Manager, Satellite Servicing Project  
Llewellyn Nicholson, EUVE Flight Operations Director  
Robert Spiess, EUVE Spacecraft Manager  
John Beckham, Delta Project Manager

### **University of California, Berkeley:**

Prof. Stuart Bowyer, EUVE Science Principal Investigator  
Dr. Roger Malina, Instrument Principal Investigator  
Dr. Carol Christian, EUVE Guest Observer Project Scientist

### **Kennedy Space Center:**

Robert L. Crippen, Center Director  
John T. Conway, Director of Payload Management and Operations  
J. L. Womack, Director, Expendable Vehicles, NASA Launch Manager  
JoAnn H. Morgan, Director, Payload Projects Management  
Thomas Rucci, EUVE Launch Site Support Manager

### **USAF 45th Space Wing, Patrick AFB:**

Brig. Gen. Jimmy R. Morrell, Commander  
Col. Michael R. Spence, Commander 45th Operations Group  
Lt. Col. Randolph M. Moyer, Commander, 1st Space Launch Squadron,  
Launch Director

**McDonnell Douglas Space Systems Company:**

Rich Murphy, Director, NASA/SDIO and Commercial Programs

Lyle Holloway, Director, Launch Sites

Jerry Winchell, Program Manager, NASA Programs

Jay Witzling, Deputy Director, NASA/SDIO and Commercial Programs

Jack Dodds, Launch Conductor

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400



For Release

Michael Braukus  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

June 1, 1992

George H. Diller  
Kennedy Space Center, Fla.  
(Phone: 407/867-2468)

NOTE TO EDITORS: N92-49

## **EXTREME ULTRAVIOLET EXPLORER PRELAUNCH PRESS BRIEFING SET**

A prelaunch press briefing on NASA's Extreme Ultraviolet Explorer (EUVE) is scheduled for 11 a.m. EDT. Thursday, June 4, at the Kennedy Space Center, Fla., News Center auditorium. The briefing will be carried live on NASA Select television and the V-2 audio circuits. The spacecraft and launch vehicle status, mission science, and the prelaunch weather forecast will be covered.

The launch of EUVE is scheduled for Friday, June 5, aboard an Air Force Delta II rocket from Pad A on Launch Complex 17, Cape Canaveral Air Force Station. The launch window extends from 12:23 p.m. to 1:43 p.m. EDT.

NASA Select is available on Satcom F2R, transponder 13, 72 degrees west longitude. Audio only is available on the V-2 circuits at 867-1220, 1240 and 1260.

- end -

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400



For Release

Brian Dunbar  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

June 2, 1992

Debra J. Rahn  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-8455)

Robert MacMillin  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

(NOTE TO EDITORS: N92-50

## **COVERING THE TOPEX/POSEIDON LAUNCH**

This summer the TOPEX/POSEIDON satellite will be launched aboard an Ariane IV launch vehicle from the Guiana Space Center (CSG) in Kourou, French Guiana. TOPEX/POSEIDON is a joint program of NASA and the Centre Nationale d'Etudes Spatiales, the French space agency, to study ocean circulation and its role in regulating the global climate.

Reporters interested in covering the launch should contact Brian Dunbar at NASA Headquarters on 202/453-1547 for accreditation by June 19. CSG will reserve hotel rooms for the press and provide transportation for press tours and launch. Reporters are responsible for their own travel arrangements. In the CSG newsroom, reporters can use individual telephones provided by CSG, which will bill each reporter's organization.

Travel to French Guiana requires a valid passport and French visa. Health regulations require inoculation against yellow fever one month in advance of travel. Other medical treatments, such as malaria suppressants, are advisable; reporters should consult their physicians. All standard vaccinations should be up to date.

Contact the NASA Public Affairs Office at 202/453-1547 for more information about the TOPEX/POSEIDON mission.

- end -



For Release

Ed Campion  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-1134)

June 2, 1992

Jeffrey Carr  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

( NOTE TO EDITORS: N92-51

## **STS-46 PREFLIGHT BRIEFINGS SET**

A series of press briefings on Space Shuttle mission STS-46, set for launch July 16, will be held on Thursday, June 11, from 9 a.m. to 5 p.m. EDT at the Johnson Space Center, Houston.

STS-46 will feature the deployment of the European Space Agency's (ESA) European Retrievable Carrier (EURECA) - a free-flying experiment and processing platform - on the second day of the flight. The mission will also include the first flight of the NASA/Italian Space Agency's (ASI) Tethered Satellite System (TSS) - a unique Shuttle-borne experiment facility designed to deploy, maintain at a distance and retrieve scientific payloads using a conductive tether. The week-long mission aboard the Space Shuttle Atlantis will be manned by a multi-national crew representing NASA, ESA and the ASI.

The briefings will be carried on NASA Select television (Satcom F2R, transponder 13, 72 degrees west longitude). An extended crew press conference will be held in lieu of round robin interviews. Two-way Q&A will be available at NASA Headquarters and major field centers.

In addition, a roundtable discussion with key representatives of the TSS mission and news media at Johnson will focus on the unique challenges of preparing to conduct these investigations in orbit. This discussion will also be carried on NASA Select television.

The briefing schedule follows:

- more -

- 2 -

(all times EDT)

9 a.m.	Mission Summary Briefing
9:45 a.m.	EURECA Background Briefing
10:30 a.m.	TSS Background Briefing
11:15 a.m.	TSS Operations and Science Briefing
12:30 p.m.	Flight Crew Press Conference
2 p.m.	Lunch Break
3:30 p.m.	TSS Roundtable Discussion

- end -



Terri Sindelar  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

For Release  
June 2, 1992

EDITORS NOTE: N92-52

## **NASA ADMINISTRATOR AND ASTRONAUTS VISIT LOCAL SCHOOL**

NASA Administrator Daniel S. Goldin and the crew of Space Shuttle Atlantis STS-45 will participate in a community celebration of International Space Year and will dedicate the Enterprise Mission Classroom program on Wednesday, June 3, from 10 a.m. to 12:15 p.m. at Dunbar Senior High School, 1301 New Jersey Ave., N.W., Washington, D.C.

Dunbar students and faculty, along with community volunteers, have planned various hands-on space education activities, such as robot demonstrations and observing the solar system, for elementary and junior high school students to celebrate International Space Year 1992.

The opening ceremony will take place at 10 a.m. at the football stadium. Astronauts Brian Duffy, David C. Leestma and Michael Foale will host the ceremony, which features a model rocket launch, and meet with 120 elementary students and teachers from six area schools and with 75 Dunbar students.

Meanwhile, astronauts Charles F. Bolden, Kathryn Sullivan and Byron Lichtenberg will tour the Enterprise Mission Classroom and meet with students.

NASA Administrator Goldin also will tour the Enterprise Mission Classroom and speak with students from 10:45 a.m. to 11 a.m.

The Enterprise Mission Dedication Ceremony will be held in the school's Media Center at 11 a.m. Dr. Eva Rousseau, Principal of Dunbar High School, will open the program and introduce the six astronauts. Goldin will be the keynote speaker discussing the future generation of scientists and engineers.

Student leaders will discuss the Enterprise Mission Classroom and present awards to various individuals and corporations who helped create the pilot, state-of-the-art classroom that teaches science and math by using space data and images.

- end -

For Release

Paula Cleggett-Haleim  
NASA Headquarters, Washington, D.C.  
(Phone: 202 453-1547)

EMBARGOED UNTIL 11:00 a.m.  
June 2, 1992

Jim Elliott  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-6256)

Ray Villard  
Space Telescope Science Institute, Baltimore, Md.  
(Phone: 410/338-4514)

RELEASE: 92-80

## **NASA'S HUBBLE SPACE TELESCOPE UNCOVERS A STARBURST GALAXY**

NASA's Hubble Space Telescope (HST) has revealed a new class of object in the universe -- a grouping of gigantic star clusters produced by the collision of galaxies. Images of the core of the peculiar galaxy Arp 220 show that stars are produced at a furious rate from the dust and gas supplied by the interaction of two galaxies.

The discovery was made by Dr. Edward Shaya and graduate student Dan Dowling, University of Maryland, College Park, and the Wide Field/Planetary Camera Team.

Astronomers have never before seen a "starburst galaxy" in such detail. The core of Arp 220 promises to be a unique laboratory for studying supernovas (the self-detonation of massive stars) because they should explode frequently in gigantic young clusters.

Over time, the core of this galaxy should resemble a string of firecrackers popping off. This will provide astronomers an unprecedented opportunity to study the late evolution of massive stars, as well as possibly improve techniques for measuring distances to galaxies, which use supernovae as "standard candle" distance indicators.

In the 1980s NASA's Infrared Astronomy Satellite observatory showed that Arp 220 is the brightest of a dozen or so "ultraluminous infra-red galaxies," which release 95 percent of their light in the infrared region of the spectrum.

- more -

Ground-based telescopic images show a dust lane down the center of Arp 220 which makes the galaxy appear double lobed. Astronomers suspected that Arp 220's dark lane hid a massive black hole which provided the energy for heating intervening dust which re-radiates in infrared light. These new observations show that much of the energy is provided by giant star clusters. These star clusters will drive gas into the accretion disk around the black hole.

Astronomers doubted that an incredibly swift burst of star formation could explain all of Arp 220's luminosity. It now seems that the dust is heated both by the nucleus and the giant star clusters.

The new Hubble observation seems to confirm a 1988 theory by David Sanders (University of Hawaii), which predicted that starburst activity is triggered in Arp 220 and other ultraluminous infrared galaxies as a result of mergers of two giant spiral galaxies. Additionally, Joshua Barnes, University of Hawaii, and Lars Hernquist, Lick Observatory, University of Southern California, Santa Cruz, have calculated that when two spiral galaxies merge much of the gas and dust lose angular momentum and fall into the center. This high gas density would trigger a very high rate of star formation.

HST reveals for the first time six luminous knots that are super-bright star formation regions that lie within 2,000 light-years of the bright nucleus. These clusters are much brighter and ten times larger than any previously known star cluster. The HST observers speculate there may be even more super-clusters embedded deeper in the dust lane.

"We can now interpret previous microwave observations to estimate the clusters' age to be greater than ten million years," says Shaya. "This means that they are no longer in the starburst phase." Frictional forces, however, should draw these clusters toward the center of the galaxy where gravitational tidal forces should tear them apart within 100 million years. This limited age range adds further support for the galaxy collision scenario.

Since the clusters are young they must contain an abundance of massive short-lived stars. Shaya estimates that these should explode as supernovae several times per year.

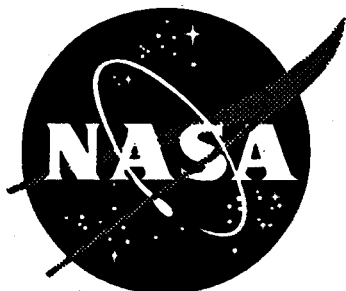
The Space Telescope Science Institute is operated for NASA by the Association of Universities for Research in Astronomy, Inc., under contract with the Goddard Space Flight Center, Greenbelt, Md. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency.

- end -

NOTE TO EDITORS: Two HST images to illustrate this release will be available to the news media Tuesday, June 2, 1992, by calling NASA's Broadcast and Imaging Branch on 202/453-8375:

Color: 92-HC-347 and 92-HC-348  
B & W: 92-H-393 and 92-H-394

92-81

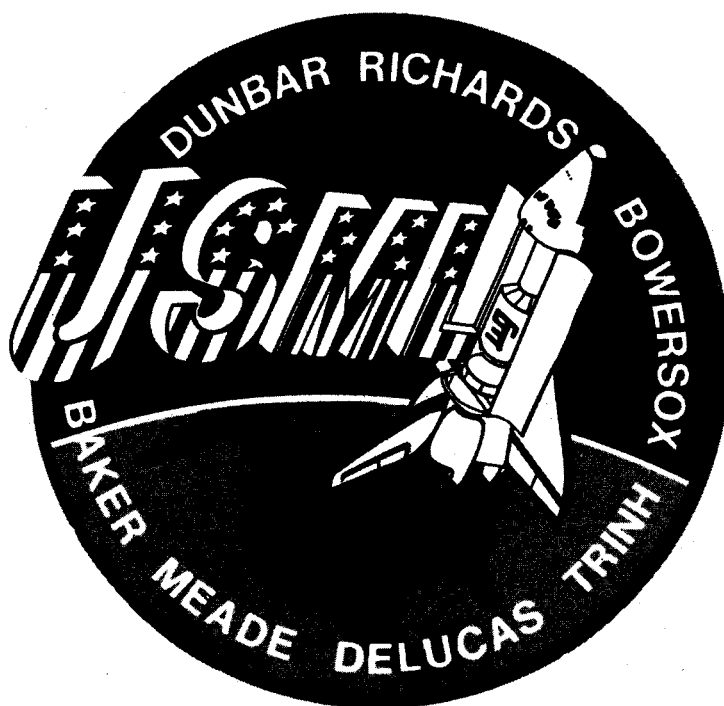


National Aeronautics and  
Space Administration

## SPACE SHUTTLE MISSION

# STS-50

### Press Kit



June 1992

## **PUBLIC AFFAIRS CONTACTS**

Ed Campion  
Office of Space Flight  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-8536)

Michael Braukus  
Office of Space Science and Applications  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

Barbara Selby  
Office of Commercial Programs  
NASA Headquarters, Washington, D.C.  
(Phone: 703/557-5609)

Jane Hutchison  
Ames Research Center, Mountain View, Calif.  
(Phone: 415/604-9000)

James Wilson  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

Lisa Malone  
Kennedy Space Center, Fla.  
(Phone: 407/867-2468)

Jean Clough  
Langley Research Center, Hampton, Va.  
(Phone: 804/864-6122)

Mary Ann Peto  
Lewis Research Center, Cleveland, Ohio  
(Phone: 216/433-2899)

June Malone/David Drachlis  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205/544-0034)

James Hartsfield  
Johnson Space Center, Houston, Texas  
(Phone: 713/483-5111)

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RELEASE: 92-81

## **48th SHUTTLE MISSION TO BE LONGEST, FOCUS ON WEIGHTLESSNESS**

The longest flight ever for a Space Shuttle and around-the-clock investigations of the effects of weightlessness on plants, humans and materials will highlight Shuttle mission STS-50.

The 48th flight of a Space Shuttle and the 12th flight of Columbia, STS-50, carrying the U.S. Microgravity Laboratory-1 (USML-1), is planned for launching at 12:05 p.m. EDT on late June. The mission is scheduled to last 12 days, 20 hours and 28 minutes, with landing planned at Edwards Air Force Base, Calif.

Richard N. Richards, 45, Capt., USN, will command STS-50, his third space flight. The pilot will be Kenneth D. Bowersox, 36, Lt. Cmdr., USN, making his first space flight. Mission specialists include Bonnie Dunbar, 43, who also will be Payload Commander and making her third flight; Ellen Baker, 39, making her second flight; and Carl Meade, 41, Col., USAF, making his second flight. Payload specialists include Lawrence J. DeLucas, 41, from the Center for Macromolecular Crystallography at the University of Alabama, making his first flight, and Eugene H. Trinh, 41, a research physicist on the Space Station Freedom experiments planning group, making his first flight.

USML-1 includes 31 experiments ranging from manufacturing crystals for possible semiconductor use to the behavior of weightless fluids. In addition, STS-50 will carry the Investigations into Polymer Membrane Processing experiment, an experiment in manufacturing polymers, used as filters in many terrestrial industries, and the Space Shuttle Amateur Radio Experiment-II, an experiment that allows crew members to contact ham radio operators worldwide and conduct question-and-answer sessions with various schools.

Columbia is currently the only Shuttle capable of a 13-day flight and will carry the necessary additional hydrogen and oxygen supplies on a pallet in the cargo bay. New systems for removing carbon dioxide from the crew cabin, for containing waste and for increased stowage of food and crew equipment also have been added.

The crew will perform several ongoing medical investigations during the flight as well, research that aims at counteracting the effects of prolonged exposure to weightlessness on the human physique.

- end of general release -

## STS-50 QUICK LOOK FACTS

Orbiter:	Columbia (OV-102)
Launch Date and Time:	Late June 1992
Launch Window:	3 hours, 8 min. (12:05 - 3:13 p.m. EDT)
Launch Site:	Kennedy Space Center, Fla., Pad 39-A
Altitude/Inclination:	160 n.m. x 160 n.m./28.5 degrees
Mission Duration:	12/20:28:00 MET
Primary Landing Site:	Edwards Air Force Base, Calif.
Abort Landing Sites:	Return to Launch Site - Kennedy Space Center, Fla. Transoceanic Abort Landing - Banjul, The Gambia Alternates - Ben Guerir, Morocco; Rota, Spain Abort Once Around - Edwards Air Force Base, Calif.
Crew:	Dick Richards, Commander Ken Bowersox, Pilot Bonnie Dunbar, Mission Specialist 1, Payload Commander Ellen Baker, Mission Specialist 2 Carl Meade, Mission Specialist 3 Larry DeLucas, Payload Specialist 1 Gene Trinh, Payload Specialist 2
Cargo Bay Payloads:	U. S. Microgravity Laboratory-1 (USML-1) Crystal Growth Furnace (4 experiments) Drop Physics Module (3 experiments) Surface Tension Driven Convection Experiment Solid Surface Combustion Experiment Glovebox (16 experiments) Space Acceleration Measurement System(SAMS)
Middeck Payloads:	Astroculture-1 (ASC-1) Generic Bioprocessing Apparatus (GBA) Commercial Protein Crystal Growth (CPCG) Zeolite Crystal Growth (ZCG)
Secondary Payloads:	Extended Duration Orbiter Medical Project (EDOMP) Investigations into Polymer Membrane Processing (IPMP) Orbital Acceleration Research Experiment (OARE) Shuttle Amateur Radio Experiment-II (SAREX-II) Ultraviolet Plume Instrument (UVPI)

## STS-50 VEHICLE AND PAYLOAD WEIGHTS

	<u>Pounds</u>
Orbiter (Columbia) empty, and 3 Space Shuttle Main Engines .....	181,344
U. S. Microgravity Laboratory.....	22,199
Protein Crystal Growth.....	229
Investigation of Polymer Membrane Processing.....	36
Shuttle Amateur Radio Experiment.....	52
Zeolite Crystal Growth .....	126
Generic Bioprocessing Apparatus .....	69
Detailed Supplementary Objectives .....	248
Detailed Test Objectives .....	122
Extended Duration Orbiter Pallet.....	3,597
Total Vehicle at Solid Rocket Booster Ignition.....	4,523,834
Orbiter Landing Weight .....	228,866

## STS-50 TRAJECTORY SEQUENCE OF EVENTS

<u>EVENT</u>	<u>MET</u> <u>(d:h:m:s)</u>	<u>RELATIVE</u> <u>VELOCITY</u> <u>(fps)</u>	<u>MACH</u>	<u>ALTITUDE</u> <u>(ft)</u>
Launch	00/00:00:00			
Begin Roll Maneuver	00/00:00:10	189	.17	800
End Roll Maneuver	00/00:00:14	301	.27	1,968
SSME Throttle Down to 67%	00/00:00:35	842	.77	12,795
Maximum Dyn. Pressure (Max Q)	00/00:00:51	1,178	1.13	27,314
SSME Throttle Up to 104%	00/00:01:02	1,464	1.49	39,895
SRB Separation	00/00:02:04	4,167	3.95	55,799
Main Engine Cutoff (MECO)	00/00:08:31	24,572	22.73	63,636
Zero Thrust	00/00:08:37	24,509	N/A	62,770
External Tank Separation	00/00:08:50			
Orbital Maneuvering System-2 Burn	00/00:34:55			
Landing	12/20:28:00			

Apogee, Perigee at MECO: 156 x 35 nautical miles

Apogee, Perigee post-OMS 2: 162 x 160 nautical miles

## SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, orbiter and its payload. Abort modes include:

- **Abort-To-Orbit (ATO)** -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.
- **Abort-Once-Around (AOA)** -- Earlier main engine shutdown with the capability to allow one orbit around the Earth before landing at either Edwards Air Force Base, Calif., White Sands Space Harbor, N.M., or the Shuttle Landing Facility (SLF) at the Kennedy Space Center, Fla.
- **Trans-Atlantic Abort Landing (TAL)** -- Loss of one or more main engines midway through powered flight would force a landing at either Banjul, The Gambia; Ben Guerir, Morocco; or Rota, Spain.
- **Return-To-Launch-Site (RTL)** -- Early shutdown of one or more engines, without enough energy to reach Banjul, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

STS-50 contingency landing sites are Edwards Air Force Base, the Kennedy Space Center, White Sands Space Harbor, Banjul, Ben Guerir and Rota.

## **THE U.S. MICROGRAVITY LABORATORY-1 MISSION**

The U. S. Microgravity Laboratory (USML) -1 and subsequent missions will bring together representatives from academia, industry and the government to study basic scientific questions and gain new knowledge in materials science, biotechnology, combustion science, the physics of fluids and the way energy and mass are transported within them. The U.S. Microgravity Laboratory series will help the United States maintain world leadership in microgravity research and development.

As Space Station Freedom development proceeds, the USML missions will continue development and testing of experimental flight equipment and will be laying the scientific foundation for microgravity research conducted over extended time periods. In addition, USML experiments will be conducted on nutrient and water transport for growing food in space, on the behavior of fire in low-gravity and on the effects of long-term space travel on humans.

In June 1992, the USML-1 Spacelab mission -- designated STS-50 -- will be launched into a 160-nautical-mile orbit aboard the Space Shuttle Columbia. It will be a 13-day mission to perform scientific investigations using some of the latest high-technology research equipment. Because of the great number of experiments planned for the mission and to fully utilize the time in microgravity, the crew will be split into two teams. Each team will work a 12-hour shift to maintain around-the-clock operations.

### **The Laboratory**

Spacelab is a modular research laboratory flown within the Shuttle orbiter's cargo bay. It includes interchangeable elements, including open U-shaped platforms, called pallets (for equipment such as telescopes that require direct exposure to space), and short and long laboratory modules. The laboratory modules are pressurized so researchers can work in a laboratory environment in their shirt sleeves rather than bulky spacesuits. These elements are arranged in the Shuttle cargo bay to meet the unique needs of each mission.

For USML-1, the long pressurized module will be used. This 23-foot-long laboratory workshop will contain a series of standard racks that will hold furnaces for growing crystals, facilities for studying the behavior of fluids and doing combustion research, computers and other equipment needed for the various experiments.

During USML-1, as with all NASA Spacelab missions, flight controllers and experiment scientists direct science activities from the Spacelab Mission Operations Control Center in Huntsville, Ala. They have a direct voice communication link with the orbiting Spacelab crew, and on-board video cameras make it possible for them to view crew and experiment activities. Scientists and controllers on the ground can receive information from Spacelab experiments and send commands via computer links. With this communications access, scientists on the ground and in orbit can work together, sharing information about experiments, monitoring data, solving problems and revising experiment plans.

## Extended Mission

Shuttle missions usually have been less than 10 days. At 13 days, USML-1 will be the longest Shuttle mission to date. This will be made possible by the first use of the new Extended Duration Orbiter kit, which includes equipment and fuel for extra energy production, additional nitrogen tanks for cabin air and a regeneration system to remove carbon dioxide. The kit eventually may permit Shuttle missions up to 30 days long.

## What Is Microgravity?

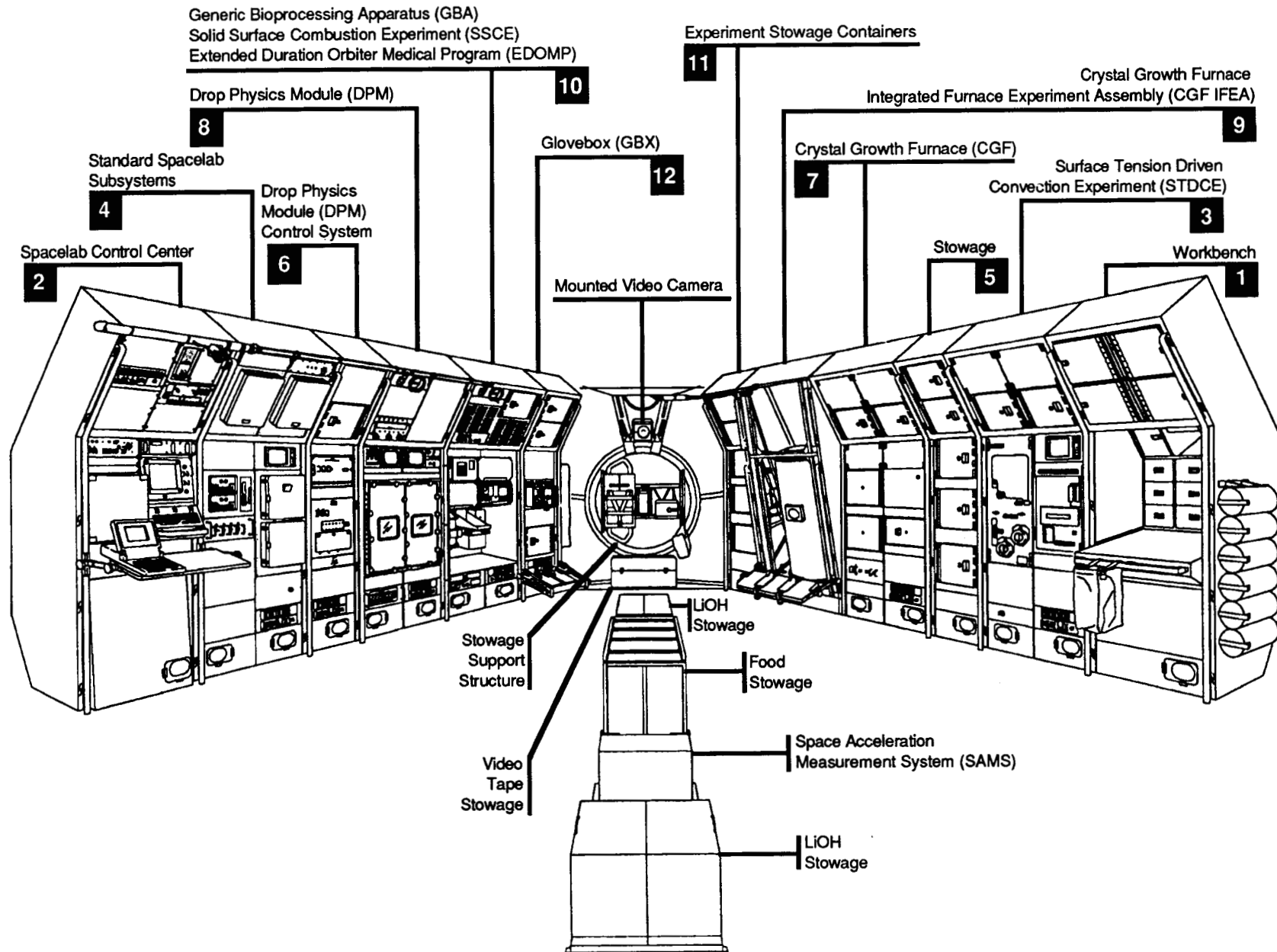
Microgravity literally means a state of very small or minute gravity. Earth's gravitational field extends far into space. It is the Shuttle's balance between that gravity, which pulls it down, and centrifugal force, created as the Shuttle flies along a circular path, that causes space travelers and anything in the Shuttle that is not secured to "float" in space as they fall free in Earth's gravitational field. Though microgravity is a relatively new term, it could become a household word in the next century as the potential benefits of space-based research are realized.

## USML-1 Experiments

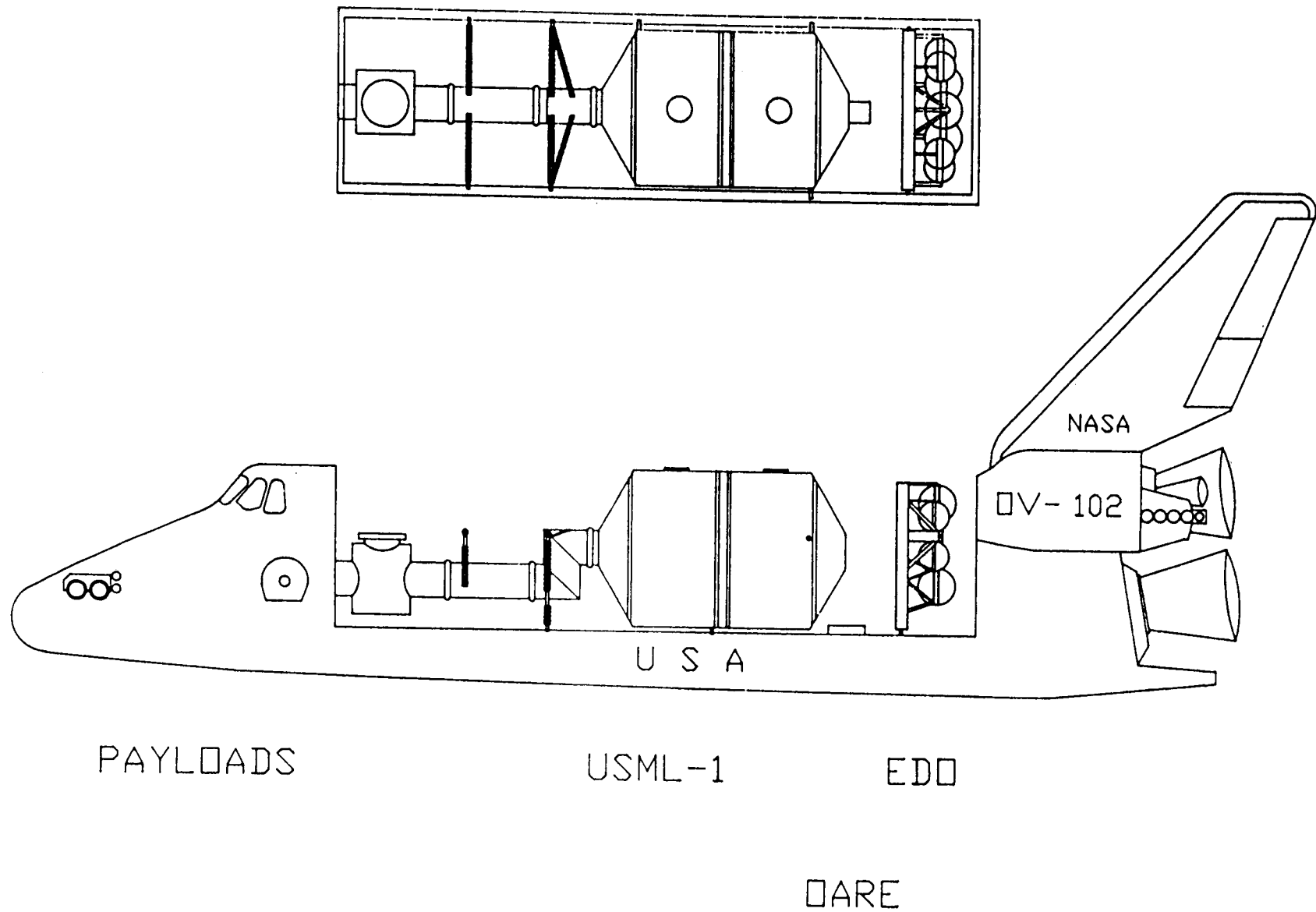
Equipment used and data obtained during earlier Shuttle missions provide a basis on which many of the USML-1 investigations will build. During the USML-1 mission, 31 experiments will be conducted in four broad areas -- **materials science, fluid physics, combustion science and biotechnology** -- in addition to the study of accelerations in the Shuttle and the complementary glovebox experiments.

Laboratory hardware includes new equipment, such as the Crystal Growth Furnace, and some equipment that has flown previously, such as the Solid Surface Combustion Experiment.

# FIRST UNITED STATES MICROGRAVITY LAB (USML-1)



# STS-50 Cargo Configuration



## **MATERIALS SCIENCE**

While in space, materials can be formed in ways not possible on Earth. Research performed in the microgravity environment of Spacelab has greatly reduced gravitational effects, such as settling and separation of components and convection.

The Crystal Growth Furnace is new equipment developed specifically to study directional solidification of materials (primarily semi-conductors), which form the basis of electronic devices. Over the past few decades, semiconductor technology has revolutionized our lifestyle through consumer goods such as smaller, faster computers, more precise timepieces and a wide variety of audio/video and other communication equipment that just a few years ago were found only in science fiction.

The Crystal Growth Furnace is one of the first U.S. furnaces developed for spaceflight that processes samples at temperatures above 2,300 degrees Fahrenheit (approximately 1,300 degrees Centigrade). This reusable equipment will help scientists investigate the different factors affecting crystal growth and explore the best methods to produce better crystals.

Four experiments to be conducted in the Crystal Growth Furnace will result in crystals grown from different materials: cadmium telluride, mercury zinc telluride, gallium arsenide and mercury cadmium telluride. These crystals are used in infrared detectors found in certain medical equipment, night-vision goggles and sensors used in some telescopes.

In the orbiter crew cabin mid-deck area, zeolite crystals will be grown. Zeolite crystals act as sponges or filters. They are called molecular sieves because they strain out specific molecules from a compound. High-quality zeolites may one day allow gasoline, oil and other petroleum products to be refined less expensively.

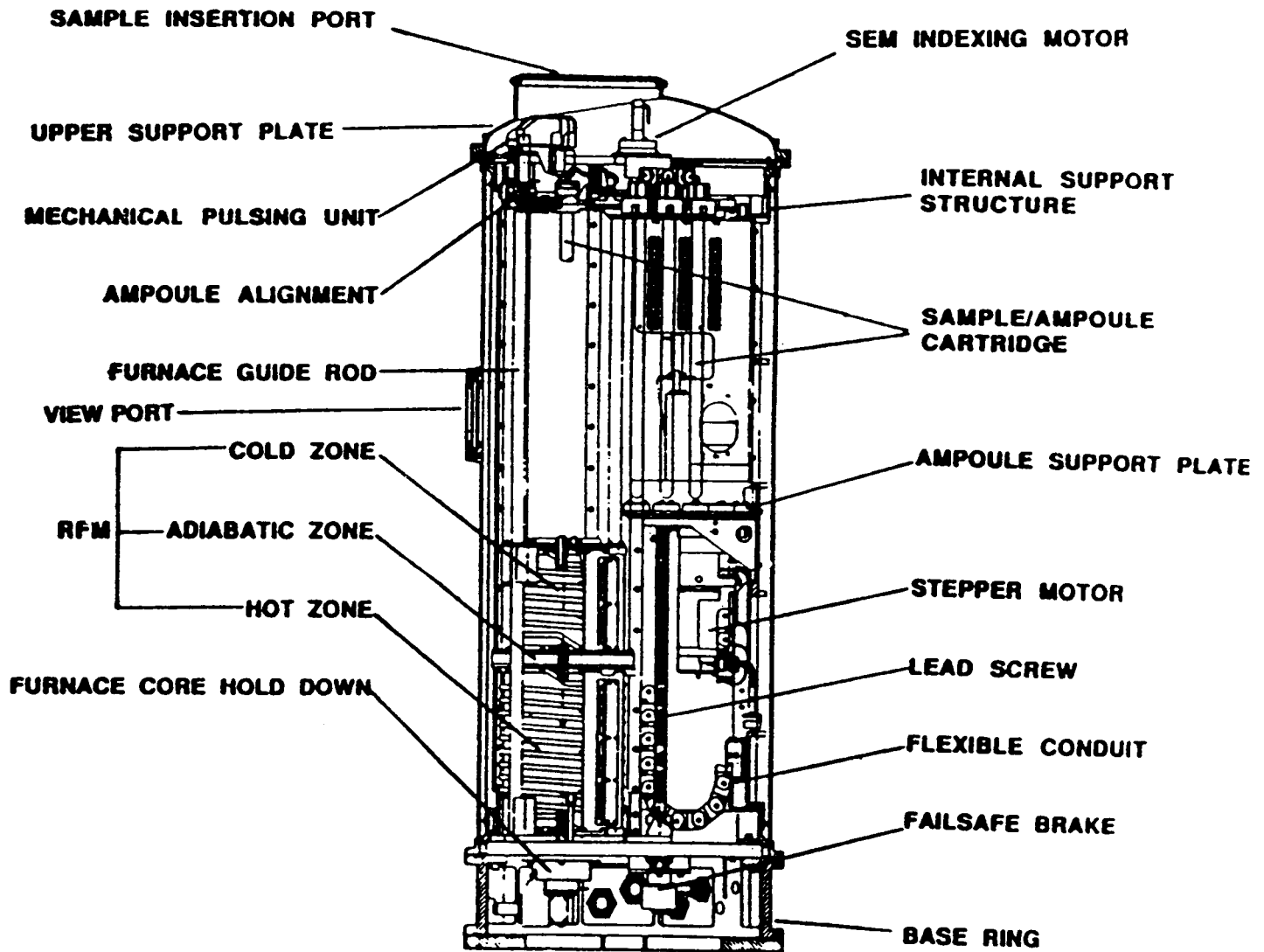
Protein crystal growth experiments -- also conducted in the mid-deck -- will study the growth of crystals in a low-gravity environment. Proteins are large, complex compounds made of a very specific arrangement of amino acids present in all life forms. Like the minerals named above, proteins also can have a crystalline structure.

The function of a certain type of protein is determined by its molecular arrangement. By understanding how a protein is structured, scientists may be better able to develop foods that have improved nutritional value. Also, medicines that act in a specific way with fewer side effects or new medicines to treat diseases may be designed.

### **CRYSTAL GROWTH FURNACE EXPERIMENTS**

On USML-1, four principal investigators (PIs) will use the Crystal Growth Furnace (CGF) to study the effect of gravity on the growth of a variety of materials having electronic and electro-optical properties. Gravity contributes to the formation of defects during the production of crystals of these materials through convection, sedimentation and buoyancy effects. These gravity-induced complications result in problems ranging from structural imperfections to chemical inhomogeneity. By conducting crystal growth research in microgravity, scientists can investigate the different factors affecting crystal growth and determine the best methods to produce various types of crystals.

# CGF



CGF INTEGRATED FURNACE EXPERIMENT ASSEMBLY (IFEA)

The CGF is the first space furnace capable of processing multiple large samples at temperatures up to 1800°F (1350°C). The CGF consists of three major subsystems: the Integrated Furnace Experiment Assembly (IFEA), the Avionics Subsystem and the Environmental Control System (ECS). The IFEA houses a Reconfigurable Furnace Module (RFM) -- a modified Bridgman-Stockbarger furnace with five controlled heating zones -- a Sample Exchange Mechanism capable of holding and positioning up to six samples for processing and a Furnace Translation System which moves the furnace over each sample. Sample material is contained in quartz ampoules mounted in containment cartridges. Thermocouples mounted in each cartridge provide temperature data. The Avionics Subsystem monitors and controls the CGF experiments and provides the interface with the Spacelab data system. The ECS maintains and controls the argon processing atmosphere inside the IFEA and provides cooling to the outer shell of the furnace through connections to Spacelab Mission Peculiar Equipment (MPE) fluid loop.

Once on orbit, a crew member will open the IFEA and load six experiment samples into the Sample Exchange Mechanism. The samples are processed under computer control. PIs can change experiment parameters via command uplinking. A flexible glovebox is used to provide crew access to the interior of the IFEA should an ampoule/cartridge fail on orbit.

## **Orbital Processing of High-Quality CdTe Compound Semiconductors**

Principal Investigator:

Dr. David J. Larson, Jr.  
Grumman Corporation Research Center

Cadmium Zinc Telluride (CdZnTe) crystals are used as lattice-matched substrates in a variety of mercury cadmium telluride (HgCdTe) infrared detectors. Reducing defects in the CdZnTe substrate minimizes the propagation of defects into the active HgCdTe layer during its growth. The purpose of the experiment is to quantitatively evaluate the influences of gravitationally-dependent phenomena (convection and hydrostatic pressure) on the chemical homogeneity and defect density of CdZnTe.

Processing the CdZnTe crystals in microgravity could significantly improve the chemical homogeneity of the substrates, minimizing interface strain and reducing the defects that result from gravitationally dependent phenomena. This improvement in substrate quality should enhance the quality and performance of the HgCdTe active detector. An improved understanding of gravitationally-dependent thermosolutal convection on the structural and chemical quality of alloyed compound semiconductors may help improve modeling of the semiconductor growth process which, in turn, would result in improving the chemical homogeneity and defect densities of the material, as well as increasing the primary yield of high quality material for infrared applications.

The sample on USML-1 ( $\text{Cd}_{0.96}\text{Zn}_{0.04}\text{Te}$ ) will be processed using the seeded Bridgman-Stockbarger method of crystal growth. Bridgman-Stockbarger crystal growth is accomplished by establishing isothermal hot-zone and cold-zone temperatures with a uniform temperature gradient between. The thermal gradient spans the melting point of the material (1,095°C). After sample insertion, the furnace's hot and cold zones are ramped to temperature (1,175°C and 980°C respectively) establishing a thermal gradient of 25°C/cm

and melting the bulk of the sample. The furnace is then programmed to move farther back on the sample, causing the bulk melt to come into contact with the high-quality seed crystal, thus "seeding" the melt. The seed crystal prescribes the growth orientation of the crystal grown. Having seeded the melt, the furnace translation is reversed and the sample is directionally solidified at a uniform velocity of 1.6 mm/h by moving the furnace and the thermal gradient over the stationary sample.

The USML-1 sample will be examined post-flight using infrared and optical microscopy, microchemical analysis, X-ray precision lattice parameter mapping and synchrotron topography, infrared transmission, optical reflectance, photoconductance and photoluminescence spectroscopy. These characterization techniques will quantitatively map the chemical, physical, mechanical and electrical properties of the CGF flight crystal for comparison with identically processed CGF ground samples. These results will be compared quantitatively with the best results accomplished terrestrially using the same growth method. Thermal, compositional and stress models will be quantitatively compared to the experimental 1-g and microgravity results.

## **Crystal Growth of Selected II-VI Semiconducting Alloys by Directional Solidification**

Principal Investigator:

Dr. Sandor L. Lehoczky  
NASA Marshall Space Flight Center  
Huntsville, Ala.

The purpose of the experiment is to determine how the structural, electrical and optical properties of selected II-VI semiconducting crystals are affected by growth in a low-gravity environment. On USML-1, the PI will investigate mercury zinc telluride ( $\text{HgZnTe}$ ), with particular emphasis on compositions appropriate for infrared radiation detection and imaging in the 8- to 12-micrometer wavelength region. Infrared detection and imaging systems at those wavelengths have the potential for use in applications ranging from resource detection and management on Earth to deep-space imaging systems. On Earth, gravity-induced fluid flows and compositional segregation make it nearly impossible to produce homogeneous, high-quality bulk crystals of the alloy.

The PI will attempt to evaluate the effect of gravitationally driven fluid flows on crystal composition and microstructure and determine the potential role of irregular fluid flows and hydrostatic pressure effects in causing crystal defects. The flight experiment should produce a sufficient quantity of crystal to allow the PI to perform bulk property characterizations and fabricate detectors to establish ultimate material performance limits.

The sample on USML-1 ( $\text{Hg}_{0.84}\text{Zn}_{0.16}\text{Te}$ ) will be processed using the directional solidification crystal growth method. The hot zone of the CGF furnace will be  $800^{\circ}\text{C}$  for melting, and the cold zone will be  $350^{\circ}\text{C}$ . A portion of the sample will be melted in the hot zone, and crystal growth will occur in the resulting temperature gradient. The furnace and thus, the temperature gradient, will be moved slowly across the sample at a rate of approximately 3.5 mm per 24 hrs. The slow rate is required to prevent constitutional supercooling ahead of the solidification interface.

The sample produced on USML-1 will be examined after the mission for chemical homogeneity and microstructural perfection by using a wide array of characterization techniques, including optical and electron microscopy, X-ray diffraction, X-ray topography and X-ray energy dispersion, infrared transmission spectroscopy and galvanomagnetic measurements as a function of temperature and magnetic field. Selected slices from the crystal will be used to fabricate device structures (detectors) for further evaluation.

### **Study of Dopant Segregation Behavior During Growth of GaAs in Microgravity**

Principal Investigator:

Dr. David H. Matthiesen  
GTE Laboratories Incorporated

Typically, semiconductors have a very small amount of impurity added to them to precisely engineer their material properties. These impurities, called dopants, are usually added at a level of 10 parts per million. Because of convection in the melt on Earth, it is very difficult to precisely control dopant distribution. Inhomogeneity in dopant distribution leads to widely varying material properties throughout the crystal. This experiment investigates techniques for obtaining complete axial and radial dopant uniformity during crystal growth of selenium-doped gallium arsenide (GaAs). GaAs is a technologically important semiconductor used in a variety of applications, such as high-speed digital integrated circuits, optoelectronic integrated circuits and solid-state lasers.

This experiment will use GaAs doped with selenium to investigate the potential of the microgravity environment to achieve uniform dispersal of the dopant during crystal growth. The hot zone (1,260°C) and the cold zone (1,230°C) temperatures are chosen to locate the 1,238°C melting point of GaAs in the center of the gradient zone.

The PI will analyze the USML-1 sample post-flight using a variety of techniques, including electrical measurements by Hall effect and capacitance-voltage techniques, chemical measurements by glow discharge mass spectroscopy and optical measurements by advanced quantitative infrared microscopy and Fourier transform infrared spectroscopy. These data will be compared to current analytical and computer model based theories.

### **Vapor Transport Crystal Growth of HgCdTe in Microgravity**

Principal Investigator:

Dr. Heribert Wiedemeier  
Rensselaer Polytechnic Institute, N.Y.

This experiment will investigate the relationship between convective flow, mass flux and morphology in mercury cadmium telluride (HgCdTe) crystals. HgCdTe crystals are useful as infrared detectors for a variety of defense, space medical and industrial applications. Crystals free of large structural defects and with a more even dispersion of the constituent elements may improve detector performance. To better understand the factors that influence HgCdTe crystal growth, this experiment will examine phenomena ranging from

temperature profiles to how the aspect ratio (shape) of the sample ampoule affects mass transport and crystal growth.

The USML-1 sample ( $\text{Hg}_{0.8}\text{Cd}_{0.2}\text{Te}$ ) will be processed using the vapor transport crystal growth technique. The sample material, sealed in one end of a quartz ampoule will be heated to  $625^{\circ}\text{C}$ . The vapors driven off will deposit as a crystal in the cold zone ( $455^{\circ}\text{C}$ ).

After the mission, the flight crystal will be examined using X-ray diffraction, optical microscopy, scanning electron microscope/wavelength dispersive spectroscopy, chemical etching, Hall measurement and other techniques for evaluation of morphology, structural perfection and properties of the crystals. The flight crystal may be used to fabricate an infrared detector for further examination of its device performance. The PI will evaluate the temperature profile and the geometry of the condensation region of the flight sample to determine how these factors affect mass fluxes and crystal morphology. In addition, the PI will study how the aspect ratio of the ampoule affects mass transport and crystal growth properties.

## **ZEOLITE CRYSTAL GROWTH**

Principal Investigator:

Dr. Albert Sacco  
Worcester Polytechnic Institute

NASA's Office of Commercial Programs (OCP) is sponsoring the Zeolite Crystal Growth payload, developed by the Battelle Advanced Materials Center, a NASA Center for the Commercial Development of Space (CCDS) based in Columbus, Ohio, and the Clarkson Center for Commercial Crystal Growth in Space, a CCDS based in Potsdam, N.Y.

The ZCG payload is designed to process multiple samples of zeolite crystals, providing scientists with data on the most efficient procedures and equipment for producing high-quality zeolite crystals in space.

Zeolite crystals are complex arrangements of silica and alumina which occur both naturally and synthetically. An open, three-dimensional, crystalline structure enables the crystals to selectively absorb elements or compounds. As a result, the crystals are often used as molecular sieves, making the crystals highly useful as catalysts, filters, absorbents and ion exchange materials.

Zeolite crystals produced in space are expected to be larger and more perfect than their ground-produced counterparts, providing tremendous industrial potential for space-produced crystals. Ground-produced crystals are small in size, causing severe disadvantages in absorption/separation and ion exchange processes. Knowledge gained through space-based processing of large zeolites will provide a better understanding of how zeolites act as catalysts, which could result in the development of new ground-based catalysts.

Current technology produces zeolite crystals using chemical additives, however, if large zeolite crystals can be produced without the need for additives, then the crystals could be

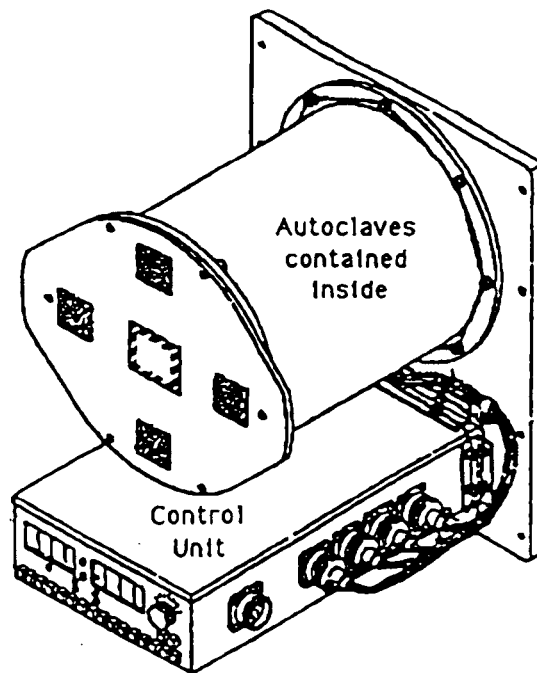
used effectively in membrane technology. Such membranes could result in major advantages over current separation techniques and have potential for numerous commercial applications. In an attempt to grow such crystals and to investigate optimal growth conditions, the ZCG experiments on this mission will be processed in the middeck and the Glovebox Module, an enclosed compartment that minimizes risks to the experiments and the Spacelab environment.

The ZCG experiment will be contained in a cylindrical ZCG furnace assembly which fits into the space of two middeck lockers and uses another locker for storage. The furnace consists of 19 heater tubes surrounded by insulation and an outer shell. Multiple samples will be processed in the furnace using three independently-controlled temperature zones of 175 degrees C, 105 degrees C and 95 degrees C.

The nucleus of the experiment will consist of 38 individually-controlled, metal autoclaves, each containing two chambers and a screw assembly. To activate the experiment, a crew member will turn the screw assembly with a powered screwdriver, pressurizing the solution in one chamber and forcing it into the other. Turning the screw assembly in the opposite direction will pull the fluid back into the emptied chamber. By repeating this process several times, proper mixing of the two solutions can be obtained (several different mixing aids and nozzle designs are to be used on this mission).

Other experiments conducted in the Glovebox Module will use clear autoclaves to determine the proper number of times the fluids should be worked to ensure proper mixing for each design. Once all of the autoclaves are activated and loaded into the furnace assembly, a cover will be secured over the front of the assembly and the furnace activated. Once the experiment is complete, the autoclaves will be removed and stored for landing. After the mission, scientists will examine the crystals to determine which growth conditions were optimum.

## ZCG



ZCG Payload

### Payload Ops:

- Accessing and operating payload
- Mixing and loading of samples
- Periodic observation of experiment status
- Video recording and downlink required
- Processed samples moved into middeck for descent and landing

## **FLUID PHYSICS EXPERIMENTS**

### **DROP PHYSICS MODULE (DPM)**

NASA Jet Propulsion Laboratory  
Pasadena, Calif.

The DPM is a major microgravity instrument supporting various experiments on the dynamics of fluids freed from the influences of gravity and the walls of a container.

Three Earth-based investigators will conduct experiments using this system in USML-1: Dr. Robert Apfel, Yale University; Dr. Taylor Wang, Vanderbilt University and Dr. Michael Weinberg, University of Arizona. Serving as Payload Specialist in USML-1 and co-investigator to the three university scientists, Dr. Eugene Trinh will be the principal operator of the DPM.

The scientists will conduct pure-science studies to investigate the internal and surface properties of liquids, seeking to verify certain fluid-dynamics theories. To get the best match with theory, the scientists need to minimize the influence of gravity which distorts the liquid's surfaces and separates the material into layers of different density.

Container walls also will distort the surfaces, whether the liquid wets them or not, and introduce chemical contamination. The DPM uses computer-controlled sound waves in a carefully-designed chamber, allowing the investigator to position fluid drops free of the chamber walls, moving them, spinning them and making them separate and flow together while their dynamic properties are observed and recorded on videotape and film.

Scientific objectives of the DPM investigations include testing and verifying theories describing the behavior of vibrating drops stimulated by sound waves, measuring physical properties of drop surfaces and studying the shapes of rotating drops and their behavior as they split into double drops. Other objectives involve understanding the dynamics of coalescence, when two free drops merge. Compound drops -- with a drop of one type of liquid inside the main drop of another -- and air-filled liquid shells also will be studied for multiple surface-tension effects and for spin dynamics.

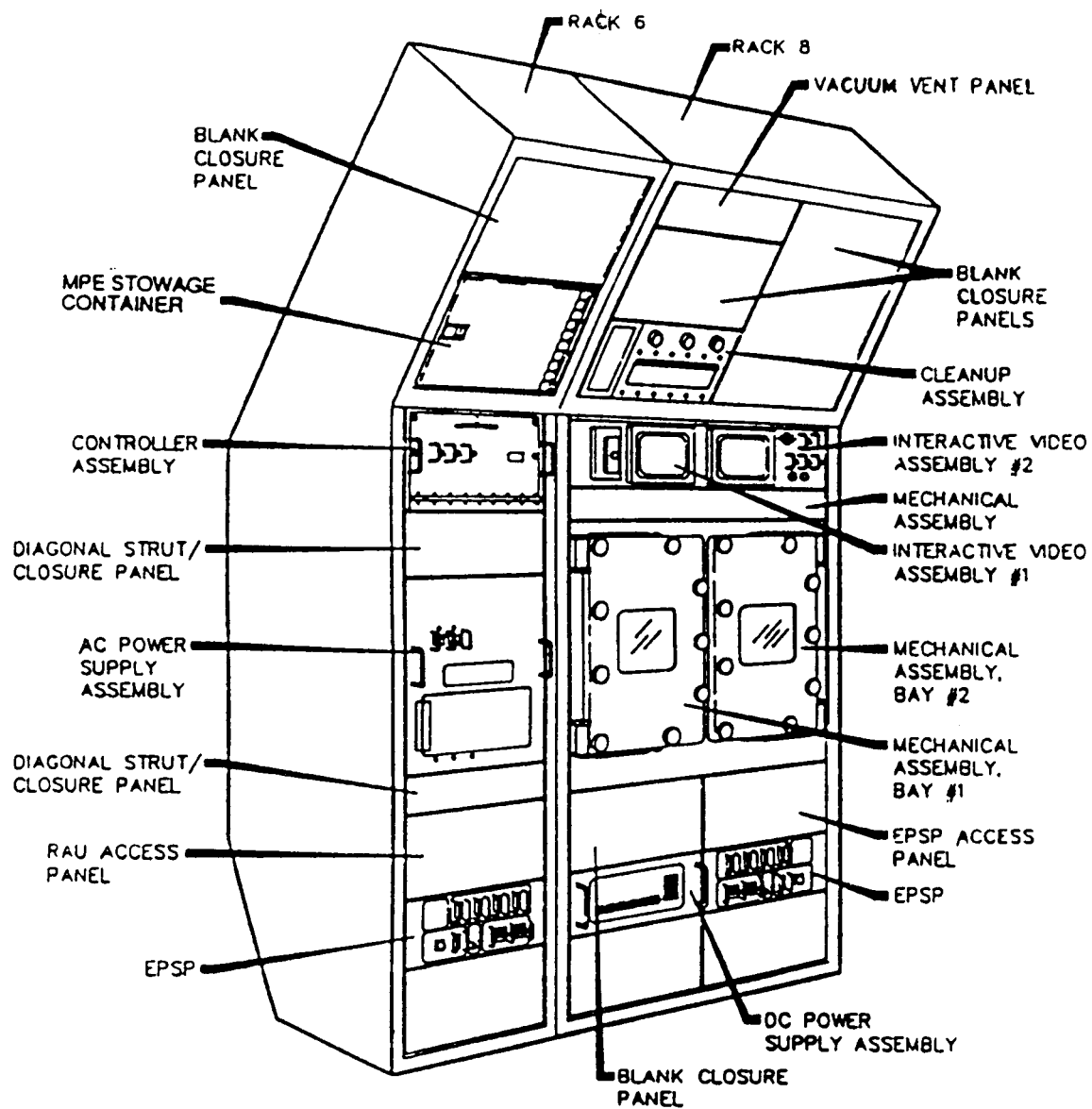
### **Science and Technology of Surface-Controlled Phenomena**

Principal Investigator:

Dr. Robert E. Apfel  
Yale University

Surface active materials (surfactants) play an important role in industrial processes, from the production of cosmetics to the dissolution of proteins in synthetic drug production to enhanced oil recovery. The PI will use the DPM to conduct two sets of experiments to understand the effect of surfactants on fluid behavior.

The first experiment will investigate the surface properties of single liquid drops in the presence of surfactants. Water drops will be positioned stably by the acoustic field of the



## DROP PHYSICS MODULE

# DPM

**Drop Physics Module.** The drop will be squeezed acoustically and then released, exciting it so that it oscillates in a quadruple shape. The frequency and damping of the resulting free oscillations will be measured. The process will be repeated both for varying surfactant concentrations and for different surfactants. These results will be analyzed to determine the static and dynamic rheological properties of the surface of liquid drops (e.g., surface viscosity, elasticity). This set of experiments, coupled with the current theoretical work of the science team, should give a better understanding of the molecular-level forces acting in the surface layer of simple water drops.

In the second group of experiments, two water drops containing varying concentrations of surfactants first will be positioned stably at separate nodes of the Drop Physics Module acoustic field. They then will be brought slowly into contact by carefully mixing acoustic modes to force the drops toward each other. If the drops do not coalesce spontaneously (which will be the case as surfactant concentrations increase), a combination of static squeezing and then forced oscillation will be applied to the contacting drops with increasing strength, inducing them to combine. Both the parameters of the induction techniques and the interface between the drops will be measured during this process in an attempt to characterize critical parameters that force the drops to rupture and coalesce. The PI will use the dual-drop coalescence experiment to gain insight into the role of surfactants as "barriers" to coalescence. These experiments also may yield practical knowledge by determining an energy-efficient approach to enhancing drop coalescence.

## **Drop Dynamics Investigation**

Principal Investigator:

Dr. Taylor G. Wang  
Vanderbilt University

Preliminary experiments using acoustic levitation to suspend liquid drops were first completed in the Drop Dynamics Module flown on the Spacelab-3 mission in 1985. These experiments not only confirmed some theories about drop behavior but also provided unexpected results. For example, the bifurcation point -- when a spinning drop takes a dog-bone shape to hold itself together -- came earlier than predicted under certain circumstances. On USML-1, the PI team will attempt to resolve the differences between experiment and theory using the more advanced capabilities of the Drop Physics Module. The PI also will use the DPM to study large-amplitude oscillations in drop shape and the process of drop fission.

Liquid drops (water, glycerin and silicone oil) between 0.5 to 2.7 cm in diameter will be deployed individually or in groups in the experiment chamber at ambient temperatures and pressures. Sound waves directed at the drops will be varied in frequency and intensity as drops are rotated, fused and made to oscillate. The equilibrium shapes of both charged and uncharged liquids undergoing solid body and differential rotation will be experimentally determined. To determine the equilibrium shapes of rotating drops, the relative phase between the orthogonal acoustic waves used to position each drop will be shifted by 90 degrees. This phase shift will create an acoustic rotational torque on the drop.

The shape oscillation spectra of drops also will be experimentally studied. To determine the shape oscillation frequency of both simple and compound drops, the

acoustic field will undergo carrier modulation to stimulate drop shape oscillation. The amplitude of the oscillation as a function of the modulation frequency will be studied to determine the non-linear behavior of the drop. These data will allow the equilibrium shapes and frequency spectrum of both simple and compound liquid drops, undergoing different types of rotation and oscillation, to be determined.

Finally, the PI will use the DPM to conduct encapsulation studies using sodium alginate and calcium chloride to determine methods for centering one component of a compound drop. In this experiment, sodium alginate droplets will be injected into a calcium chloride drop. The resulting compound drop will be subjected to various acoustic conditions to try to determine an optimal method of forming uniform concentric spherical membranes.

### **Measurement of Liquid-Liquid Interfacial Tension and the Role of Gravity in Phase Separation Kinetics of Fluid Glassmelts**

Principal Investigator:

Dr. Michael C. Weinberg  
University of Arizona

The experiment explores a unique method for measuring an important surface parameter -- the tension between interfaces of drops and other materials.

There are many liquid solutions that tend to separate into several liquid phases when held in an appropriate temperature range. This same process occurs in many glass systems, where it is referred to as glass-in-glass or liquid-liquid phase separation, or amorphous immiscibility. In both liquids and glasses, the rates at which these phase separation processes occur depend upon several factors, such as the temperature and the characteristics of the surface at the boundary between phases. The measurement of the liquid-liquid interfacial tension will provide one of the key quantities that governs the rate of such a process.

The experiment consists of measuring the liquid-liquid surface tension of a compound drop consisting of two liquids that do not mix. A drop containing tracer particles is deployed and then injected with an inner drop. This compound drop will be rotated in the Drop Physics Module at specified angular velocities, and the shapes of both the inner and outer drops will be distorted. After equilibration of drop shape and rotation rate, film images will be taken from two orthogonal views to record the drops' new geometries. Eight drop sets will be examined (four liquid pairs, two drop radii ratios each). The photographs will be analyzed to determine the drop distortions and will use theoretical models to calculate the liquid-liquid surface tension between the substances that make up each drop.

## **ASTROCULTURE™**

Principal Investigator:

Dr. Theodore W. Tibbitts  
Wisconsin Center for the Commercial  
Development of Space, Madison

NASA's Office of Commercial Programs is sponsoring the Astroculture™ payload, developed by the Wisconsin Center for Space Automation and Robotics (WCSAR), a NASA Center for the Commercial Development of Space (CCDS) based at the University of Wisconsin in Madison.

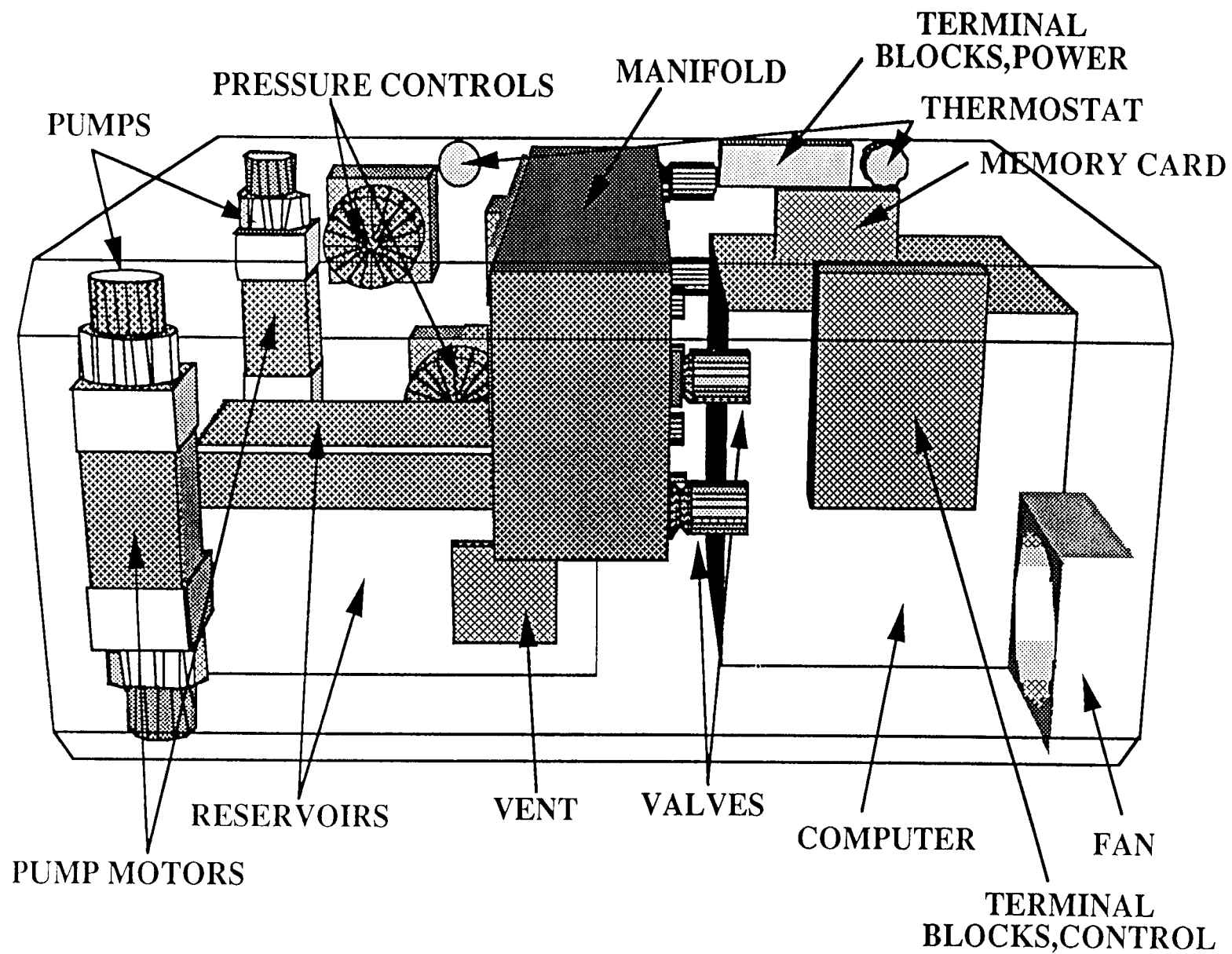
Currently, no satisfactory plant growth unit is available for support of long-term plant growth in space. Increases in the duration of Space Shuttle missions have made it necessary to develop plant growth technology that minimizes the costs of life support while in space. Plants can reduce the costs of providing food, oxygen and pure water and also lower the costs of removing carbon dioxide in human space habitats.

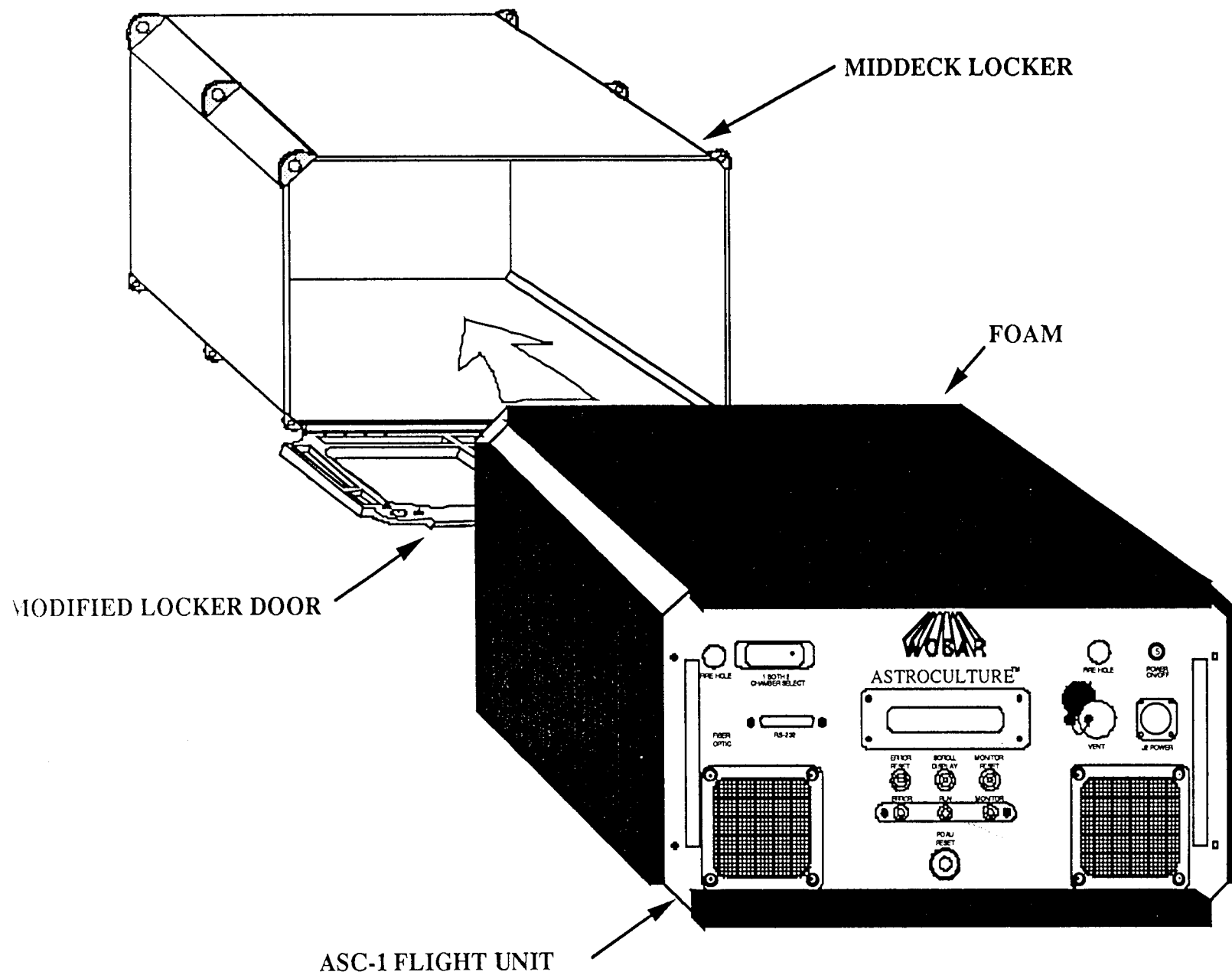
Before plants can be grown in the Astroculture™ unit, however, a series of experiments will have to be conducted on the Space Shuttle to evaluate the critical subsystems (water and nutrient delivery, lighting and humidity control) needed to construct a reliable plant growth unit. Water and nutrient delivery will be tested and evaluated on STS-50, with additional experiments added to future missions for evaluation of the other two subsystems.

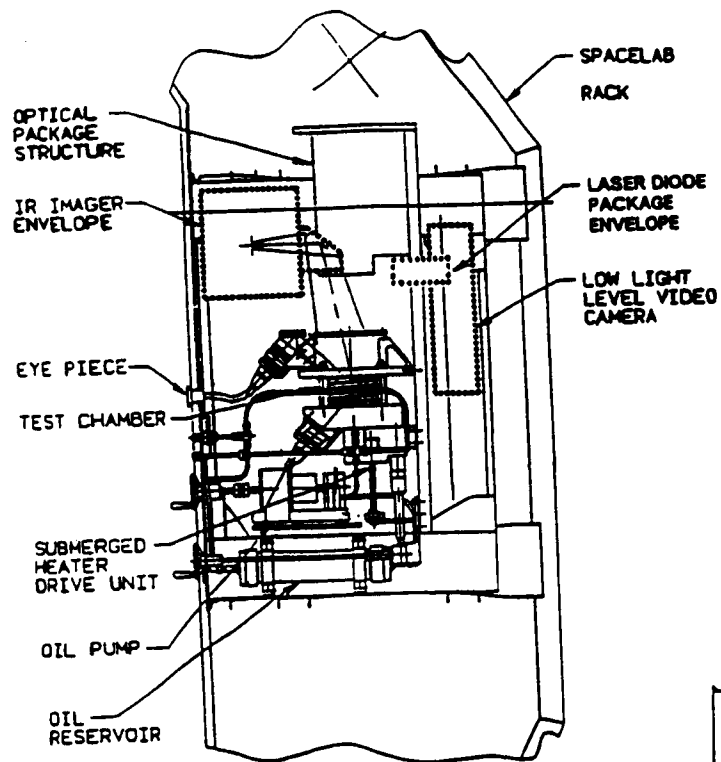
The flight hardware for the STS-50 mission is self-contained in a middeck locker and weighs approximately 70 pounds. The Astroculture™ unit consists of a covered cavity with two growth chambers containing inert material (having particle size of 20 to 40 mesh) that serve as the root matrix; a water supply system consisting of a porous stainless steel tube embedded into the matrix, a water reservoir, a pump, and appropriate valves for controlling the pressure flow of water through the stainless steel tube; a water recovery system consisting of the same components as the water supply system; and a microprocessor system for control and data acquisition functions.

In orbit, the water supply and recovery systems will be activated to initiate circulation of a nutrient solution through the porous tubes. Subsequently, the solution will move through the wall of each porous tube into the matrix by capillary forces. In the matrix, the small pores will be filled with the solution and the large pores with air, thereby providing a non-saturated state. The recovery system will operate at several pressure levels to determine the rate at which the solution will move through the matrix and the capacity of the supply system to provide the solution to the matrix.

A computer system will monitor the amount of solution pumped from the supply reservoir to the recovery reservoir. Data collected by the computer will indicate the supply system's overall capacity for replacing water and nutrients removed by plants growing in microgravity.

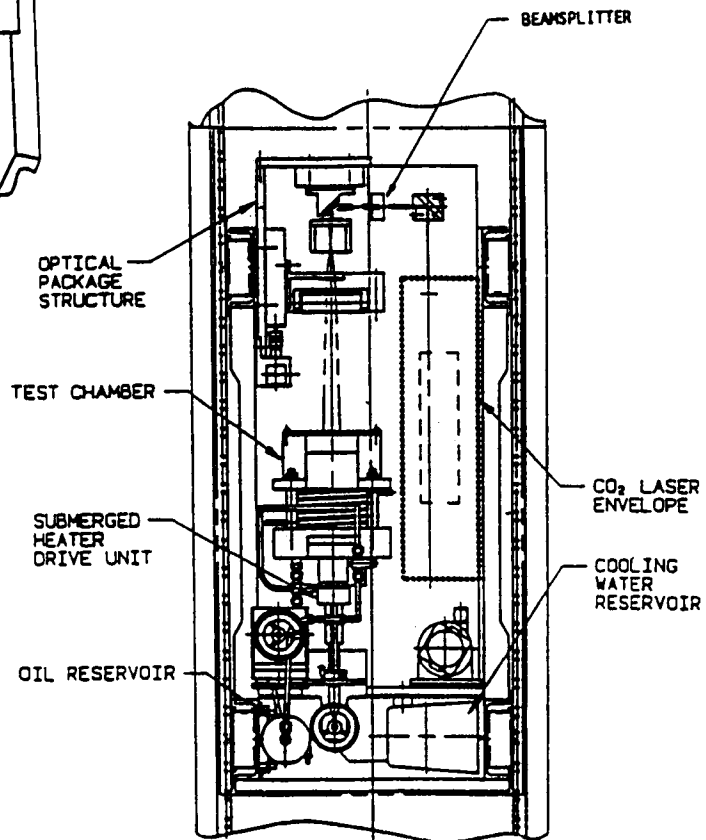




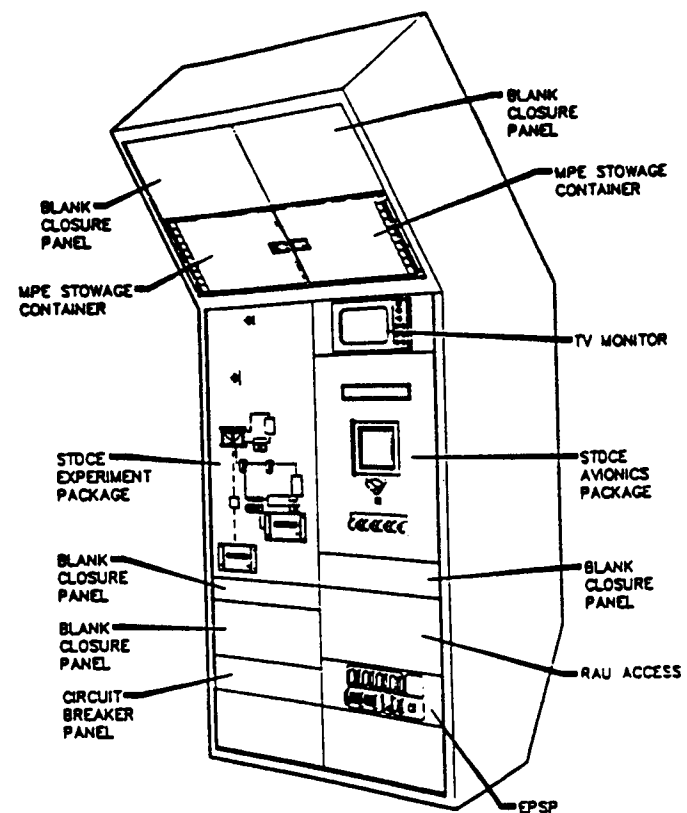


STDCE PACKAGE (SIDE VIEW)

# STDCE



STDCE PACKAGE (FRONT VIEW)



STDCE DOUBLE RACK 3 CONFIGURATION

## **SURFACE TENSION DRIVEN CONVECTION EXPERIMENT (STDCE)**

Principal Investigator:

Dr. Simon Ostrach  
Case Western Reserve University, Ohio

On Earth, buoyancy-driven flows and convection impede attempts to grow better crystals and solidify new metals and alloys. Ground-based and preliminary space experiments have shown that variations in surface tension, caused by temperature differences along a liquid's free surface, generate thermocapillary fluid flows. Although thermocapillary flows exist on Earth, they are masked by stronger buoyancy-driven flows. In low-gravity, buoyancy-driven flows are reduced, making it easier to examine thermocapillary flows. Earth's gravity also alters the liquid free surface shape and damping characteristics of any fluid. The microgravity environment allows researchers to study the impact of a variety of curved free surface geometries on thermocapillary fluid flows.

The USML-1 Surface Tension Driven Convection Experiment (STDCE) will obtain quantitative data on thermocapillary flows over a wide range of parameters in experiments that vary the imposed surface temperature distributions (thermal signatures) and the configuration of the liquid's free surface. For USML-1, both steady flows (those that do not change over time) and transient flows (those that do change over time) will be studied. A variety of conditions and experiment configurations will be used, and an attempt will be made to identify the conditions for the onset of oscillations.

The experiments will be conducted in the Surface Tension Driven Convection Experiment Apparatus, which consists of an experiment package and an electronics package located in a double Spacelab rack. The experiments are carried out in a cylindrical container (10 cm in diameter and 5 cm high). A lightweight silicone oil is used as the test fluid because it is not susceptible to surface contamination, which can ruin surface tension experiments. The experiment package contains the test chamber, made of copper to assure good thermal conductivity along the walls, and the silicone oil system, consisting of a storage reservoir and a fluid management system for filling and emptying the test chamber.

Two heating systems, which provide the different thermal signatures, are part of the test chamber. A submerged cartridge heater system will be used to study thermocapillary flows over a range of imposed temperature differences. A surface heating system will be used to investigate fluid flows generated by various heat fluxes distributed across the surface of the liquid. This heating system consists of a CO<sub>2</sub> laser and optical elements that direct the laser beam to the test chamber and vary the imposed heat flux and its distribution.

To visualize the fluid flows in the test chamber, a laser diode and associated optical elements will illuminate aluminum oxide particles suspended in the silicone oil, and a video camera, attached to a chamber view port, will record the particle motion. A scanning infrared imaging system records oil surface temperature. Thermistors inside the test chamber measure bulk oil temperatures. The crew can use a Spacelab camera mounted to the front of the chamber to monitor oil filling and draining, submerged heater positions and oil surface shapes and motions. These data will be downlinked to the Spacelab Payload Operations Control Center at the Marshall Space Flight Center. Based on the analysis of the data, a new set of test parameters for the next series of experiments will be

uplinked to the experiment computer in the Spacelab. From the data obtained, the PI will correlate velocity and temperature distributions with imposed thermal conditions to complete mathematical models of thermocapillary flow.

## **COMBUSTION SCIENCE EXPERIMENT**

### **SOLID SURFACE COMBUSTION EXPERIMENT (SSCE)**

Principal Investigator:

Robert A. Altenkirch  
Mississippi State University

The Solid Surface Combustion Experiment (SSCE) is a major study of how flames spread in microgravity. Comparing data on how flames spread in microgravity with knowledge of how flames spread on Earth may contribute to improvements in all types of fire safety and control equipment. This will be the fifth time SSCE has flown aboard the Shuttle. Ultimately, plans call for SSCE to fly a total of eight times, testing the combustion of different materials under different atmospheric conditions.

In the SSCE planned for USML-1, scientists will test how flames spread along a sample of Plexiglas in an artificial atmosphere containing oxygen mixed with nitrogen.

During the other four missions on which this experiment was flown, samples of a special filter paper were burned in atmospheres with different levels of oxygen and pressure. The special filter paper and Plexiglas were chosen as test materials because extensive databases already exist on the combustion of these materials in Earth's gravity. Thus, combustion processed on Earth and in space can be readily compared.

Scientists will use computer image enhancement techniques to analyze the film record of the Solid Surface Combustion Experiment. They then will compare the enhanced images and recorded temperature and pressure data with a computer simulation of the flame spreading process. Reconciling the two sets of data is expected to provide new insights into the basic process of combustion.

## **BIOTECHNOLOGY EXPERIMENTS**

### **PROTEIN CRYSTAL GROWTH (PCG)**

Principal Investigator:

Dr. Charles E. Bugg  
University of Alabama at Birmingham

NASA's Office of Commercial Programs (OCP) is sponsoring the Protein Crystal Growth (PCG) payload, developed by the Center for Macromolecular Crystallography (CMC), a NASA Center for the Commercial Development of Space (CCDS) based at the University of Alabama at Birmingham.

The objective of the PCG experiments is to produce large, well-ordered crystals of various proteins. These crystals will be used in ground-based studies to determine the three-dimensional structures of the proteins and to investigate the kinetics of crystal growth and the impact of fluid disturbances on crystal growth.

Since proteins play an important role in everyday life -- from providing nourishment to fighting disease -- research in this area is quickly becoming a viable commercial industry. Scientists need large, well-ordered crystals to study the structure of a protein and to learn how a protein's structure determines its functions.

The technique most-widely used to determine a protein's three-dimensional structure is X-ray crystallography, which requires large, well-ordered crystals for analysis. Crystals produced on Earth often are large enough to study, but usually they have numerous gravity-induced flaws. However, space-produced crystals tend to be purer and have more highly-ordered structures which significantly facilitates X-ray diffraction studies of the crystallized proteins.

Studies of such crystals not only can provide information on basic biological processes, but they could lead to the development of food with higher protein content, highly resistant crops and more effective drugs. By studying the growth rates of crystals under different conditions, scientists can find ways to improve crystal growth in microgravity, thus providing higher-quality crystals for study and the ability to produce large crystals made of hard-to-grow proteins. For these reasons, PCG activities have been conducted on 14 Shuttle missions counting STS-49.

On STS-50, the flight hardware will include two Refrigerator/Incubator Module (R/IM) thermal enclosures and one newly-designed thermal enclosure, called the Commercial R/IM (CRIM). The CRIM allows for a pre-programmed temperature profile and a feedback loop that monitors CRIM temperatures during flight.

To optimize protein crystal growth conditions, some of the PCG experiments will be conducted in the Glovebox Module, an enclosed compartment that minimizes risk to the experiments and the Spacelab environment. Prior to being activated, the experiments will be stowed in a R/IM set at 22 degrees C. The experiments will be conducted using modular crystal growth hardware and will include as many as 21 different proteins. Experiment parameters will be altered in response to crew observation of the crystal growth process.

New experiments will be initiated throughout the mission to take advantage of lessons learned from early experiment runs. As the PCG activities in the Glovebox are completed, the experiments will be returned to the 22-degree R/IM.

Other PCG experiments will be stowed in the other R/IM, also set at 22 degrees C, and the CRIM, set at 4 degrees C. Each will contain three vapor diffusion apparatus (VDA) trays with 20 individual growth chambers. One side of each tray holds 20 double-barreled syringes, while the other side holds plugs that cap the tips of the syringes. Protein solution will be stored in one barrel of each syringe, and the other will house precipitant solution. A reservoir of concentrated precipitant solution surrounds each syringe inside the crystal growth chamber.

To activate the experiment, a crew member will attach a handwheel to a ganging mechanism on the plug side of each VDA and turn it to retract the plugs from the syringe tips. The handwheel then will be moved to the ganging mechanism on the syringe side of the tray, where it will be turned to extrude the protein and precipitant solutions to form a drop on the tip of each syringe. The difference in concentration of the precipitant in the reservoir and the drop causes water molecules to migrate from the drop through the vapor phase into the reservoir solution. As the concentration of protein and precipitant increase in the drop, crystal growth will begin.

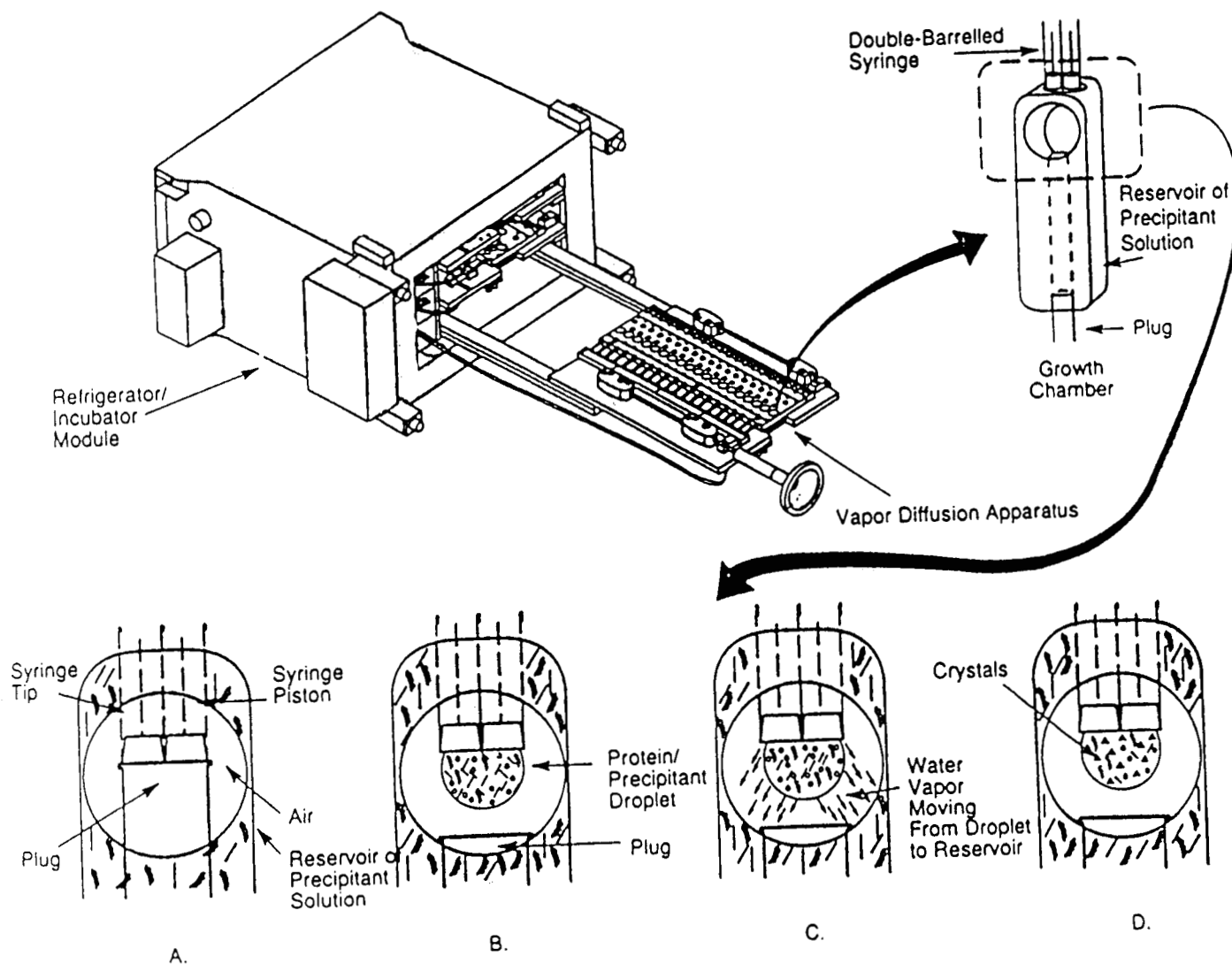
Twenty of the growth chambers are designed to accommodate crystal seeding. During the second flight day, a crew member will open a port on 10 of the seeding chambers in the VDA R/IM and inject each protein drop with a few microliters of solution containing Earth-grown "seed" crystals. The operation will be repeated on the third flight day with the remaining 10 seeding chambers. Inserting seed crystals into the protein droplets is expected to initiate immediate growth of protein crystals.

At the end of the mission, the experiments will be deactivated. Due to each protein's short lifetime and the crystals' resulting instability, the PCG payload will be retrieved from the Shuttle within 3 hours of landing and returned to the CMC CCDS for post-flight analyses.

Of the 34 proteins selected to fly on this mission, 60 percent have flown on previous flights. Nine of the proteins are OCP-sponsored and have commercial co-investigators that are affiliates of the CMC CCDS. Many have potential commercial application in the pharmaceutical industry. Structural information gained from these experiments may provide better understanding of the immune system, the function of individual genes and treatment of disease, and many ultimately aid in the design of a specific, effective and safe treatment of viral infections.

Dr. Lawrence J. DeLucas, Associate Director for PCG at the CMC CCDS, is a co-investigator and a payload specialist on the STS-50 mission, providing on-site scientific management of the PCG experiments.

## PCG HARDWARE



A double-barrelled syringe holds protein crystal growth materials separate before the experiment begins (A). A crew member turns one handwheel to withdraw the plug and another to activate pistons that push the two solutions out of the syringe and into an air space, where they form a hanging drop (B). During the mission, water vapor moves out of the drop and into a reservoir lining the growth chamber (C), thus increasing the concentration of precipitating solution in the droplet and stimulating protein crystal growth.

## GENERIC BIOPROCESSING APPARATUS

Principal Investigator:

Dr. Michael C. Robinson  
Bioserve Space Technologies  
University of Colorado in Boulder

NASA's Office of Commercial Programs is sponsoring the Generic Bioprocessing Apparatus (GBA) payload, developed by Bioserve Space Technologies, a NASA Center for the Commercial Development of Space (CCDS) based at the University of Colorado in Boulder.

The GBA is a multi-purpose payload that supports mixing of fluids and solids in up to 500 individual sample containment devices, called Fluids Processing Apparatuses (FPAs), in microgravity. On STS-50, 23 different experiments will be conducted in 132 FPAs.

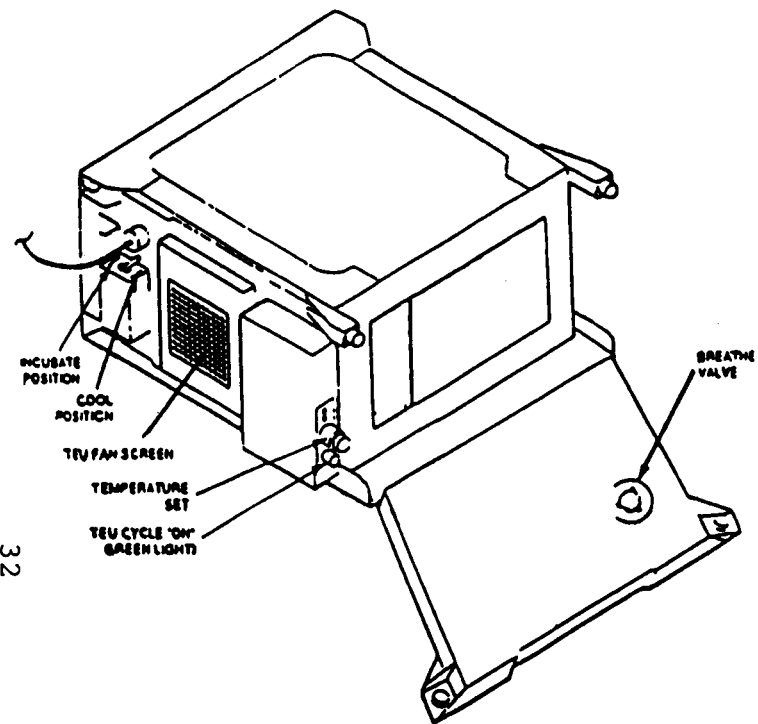
Some of the experiments will be stowed in a middeck Refrigerator/Incubator Module (R/IM), while others will be stowed in an ambient temperature stowage locker in the Spacelab module. Of the 23 experiments, one (called Directed Orientation of Polymerizing Collagen Fibers) will be processed in the Glovebox Module, an enclosed compartment that allows sample manipulation with minimal risks to the experiments and the Spacelab environment.

A crew member will activate a batch of 12 FPAs by mixing sample materials and inserting them into the GBA for incubation. A computer will automatically terminate incubation after a preprogrammed duration. A crew member then will remove the samples from the GBA, restow them in either the R/IM or Spacelab stowage locker and load another batch of samples for incubation.

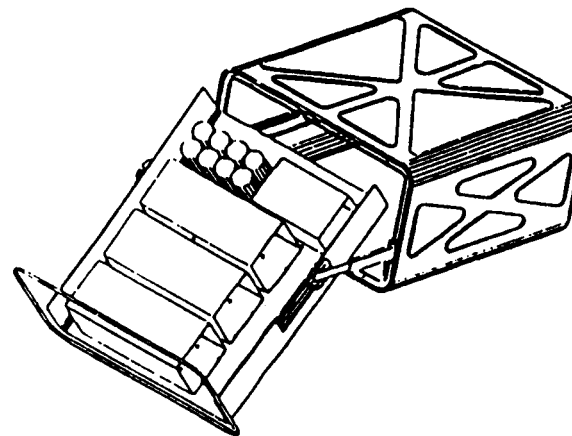
For a number of samples, on-orbit video recordings will be obtained to document sample behavior and morphology. The GBA will monitor and control its own temperature, and it will monitor optical density to provide information on processing rates and cell growth.

The GBA will allow scientists to study an array of biological processes, with samples ranging from molecules to small organisms. Some of the many commercial experiments currently scheduled to fly in the GBA include:

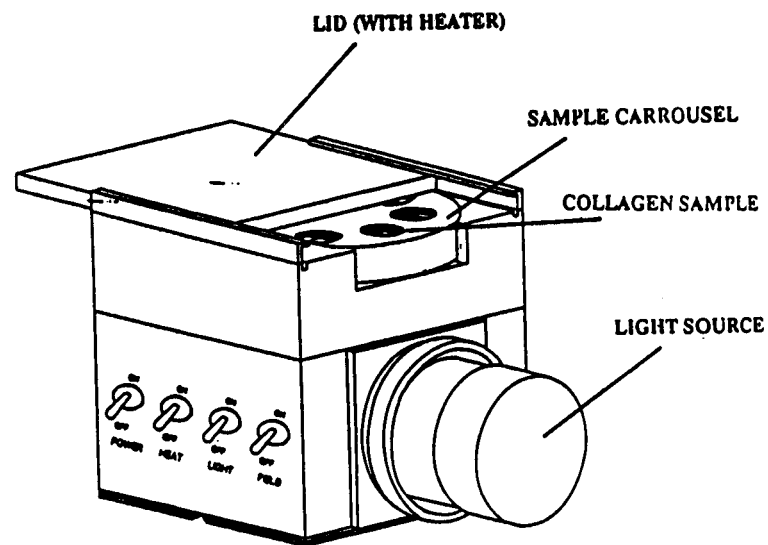
- **Artificial Collagen Synthesis** -- the ability to artificially synthesize collagen fibers in microgravity could result in materials that have the strength and properties of natural collagen. Synthesized collagen could be used more effectively as artificial skin, blood vessels, and other parts of the body.
- **Assembly of Liposomes and Virus Capsid** (two types of spherical structures that could be used to encapsulate pharmaceuticals) -- the ability to properly assemble liposomes and



**GBA REFRIGERATOR/INCUBATION  
MODULE**



**GBA PROCESSING UNIT**



**DPA MODULE**

**GBA**

virus capsid in microgravity could result in using them to navigate drugs to specific body tissues, such as tumors.

- **Development of Brine Shrimp and Miniature Wasps in Microgravity** -- could shed light on the importance of gravity in human development and aging and potential components of a Controlled Ecological Life Support System (CELSS).
- **Seed Germination and Development** -- could help develop technology for growing plants in space and provide knowledge for use in agriculture on Earth.

The ability to process such a large quantity of different samples truly exemplifies the GBA as a multi-purpose facility, helping to answer important questions about the relationship between gravity and biology. The GBA will be instrumental in evaluating the commercial potential of space-based biomaterials processes and products.

## GLOVEBOX

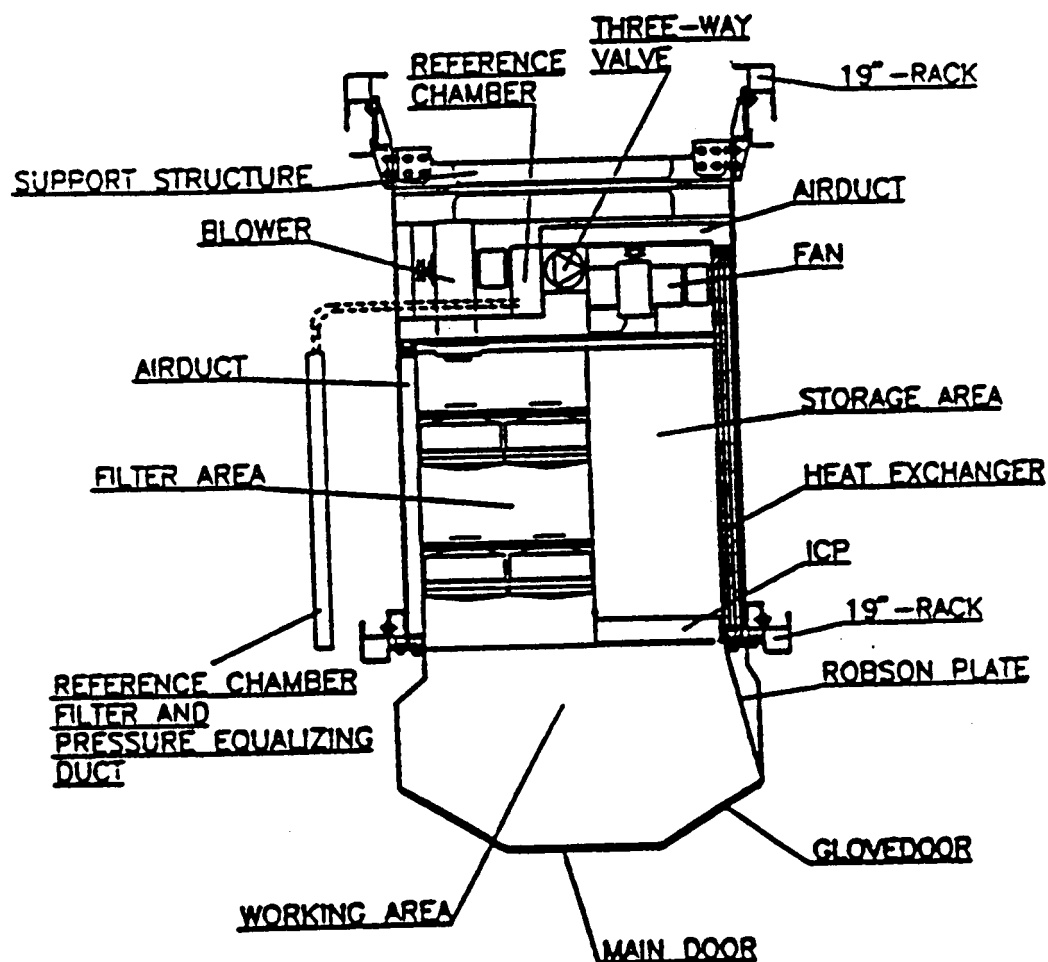
The USML-1 Glovebox (GBX), provided by the European Space Agency, is a multiuser facility supporting 16 experiments in fluid dynamics, combustion science, crystal growth and technology demonstration. Some of the experiments will provide information that other USML-1 investigations will use immediately during the mission to refine their experiment operations. Others will provide data that may be used to define future microgravity science investigations.

The GBX has an enclosed working space that minimizes the contamination risks to both Spacelab and experiment samples. The GBX working volume provides two types of containment: physical isolation from the Spacelab and negative air pressure differential between the enclosure and the Spacelab ambient environment. An air-filtering system also protects the crew from harmful experiment products. The crew manipulates experiment equipment through three doors: a central port through which experiments are placed in the working volume and two glove doors. When an airtight seal is required, the crew inserts their hands into rugged gloves attached to the glove doors. If an experiment requires more sensitive handling, the crew may don surgical gloves and insert their arms through a set of adjustable cuffs.

Most of the GBX experiment modules have magnetic bases that hold them to the steel floor of the enclosure. Others attach to a laboratory jack that can position the equipment at a chosen height above the cabinet floor. Equipment also may be bolted to the left wall of the working volume or attached outside the GBX with Velcro™.

The GBX supports four charge-coupled device (CCD) cameras, two of which can be operated simultaneously. Three black-and-white and three color camera CCD heads are available. Operations can be viewed through three view-ports or through a large window at the top of the working volume. The GBX also has a backlight panel, a 35-mm camera and a stereomicroscope that offers high-magnification viewing of experiment samples. Video data can be downlinked in real-time. The GBX also provides electrical power for experiment hardware, a time-temperature display and cleaning supplies.

# GBX



GLOVEBOX COMPONENTS

## **Passive Accelerometer System (PAS)**

Dr. J. Iwan D. Alexander  
The University of Alabama in Huntsville

The objective of PAS is to test a simple system to measure residual acceleration caused by atmospheric drag effects and the gravity gradient from the spacecraft's center of mass. Because many microgravity experiments and processes are sensitive to accelerations, it is important to measure these accelerations to improve the design of future experiments and facilities. A proof mass (steel ball) will be placed in a glass tube full of water. This tube is contained in a lexan sleeve and will be mounted parallel to the flight direction. An astronaut tracks its position manually every 1-2 minutes, using a ruler and protractor, repositioning the tube if the angular deviation of the proof mass exceeds  $10^\circ$ . Stokes' law will be used to indirectly calculate the residual acceleration from the ball's trajectory and speed. Each run will take approximately 20 minutes. This experiment will be repeated 5-10 times during the mission, at several different locations in middeck and the Spacelab.

## **Interface Configuration Experiment (ICE)**

Dr. Paul Concus  
University of California at Berkeley and Lawrence Berkeley Laboratory

ICE will explore the behavior of liquid-vapor interfaces that has been predicted mathematically for certain irregularly shaped "exotic" containers in a low-gravity environment. By demonstrating the ability to mathematically predict the shape and location of liquids in exotic containers, the researchers hope to build confidence in the ability to predict fluid configurations in containers of all shapes.

ICE has been designed to observe:

- The location and relative stability of surface shapes in mathematically designed containers
- The effects of container surface conditions on fluid behavior
- The effects of fluid properties on fluid behavior

## **Protein Crystal Growth Glovebox (PCGG)**

Dr. Lawrence J. DeLucas  
The University of Alabama at Birmingham

This experiment will be flown by the Center for Macromolecular Crystallography, a NASA Center for the Commercial Development of Space (CCDS) based at the University of Alabama at Birmingham (UAB). Individual protein crystal growth experiments are jointly sponsored by the Office of Commercial Programs and the Microgravity Science and Applications Division, Office of Space Science and Applications.

The objectives are to identify optimal conditions for nucleating and growing protein crystals in space and to investigate ways of manipulating protein crystals in microgravity. By determining the structure of protein crystals, scientists may be able to develop dramatically improved medical and agricultural products. More information is needed about optimum mixing times, solutions concentrations and other growth parameters for future microgravity protein crystal growth experiments.

The PCGG investigator, Dr. Lawrence J. DeLucas, is a USML-1 payload specialist. He and other crew members will conduct 720 interactive experiments using modular crystal growth hardware and including as many as 21 different proteins. Sample materials will be stored in a middeck R/IM for launch. Protein crystals will be grown by vapor diffusion and free interface diffusion methods. Graduated syringes with dispensing devices will be used to extrude precise amounts of proteins, buffers or precipitates. Seed crystals will be injected into equilibrated protein/precipitant solutions using micro-manipulators. The GBX microscope and a PCGG light table will be used to inspect growing crystals. Experiment parameters will be altered in response to crew observations of the crystal growth process. New experiments will be initiated throughout the mission to take advantage of lessons learned from early experiment runs. Crew members also will study ways to manipulate protein crystals and mount them in capillaries.

### **Solid Surface Wetting Experiment (SSW)**

Dr. Eugene H. Trinh  
NASA Jet Propulsion Laboratory, Pasadena, Calif.

The objective is to determine the most reliable injector tip geometry and coating for droplet deployment for Drop Physics Module (DPM) experiments. Fluids experiments in the DPM depend on efficient and accurate deployment of droplets of the proper volume and shape. Different combinations of fluids and injector nozzles will be used to deploy droplets inside the GBX working area. A micrometer drive will provide calibrated volume control of the manual injection syringe. The crew will test three different compositions of water-glycerol mixtures, as well as a variety of silicon oils. A coaxial injector will be used to inject air bubbles into some drops, so shells can be studied. Video data of droplet deployment will be recorded for post flight analysis. The crew also will measure droplet volume and wetting angles during the tests.

### **Marangoni Convection in Closed Containers (MCCC)**

Dr. Robert J. Naumann  
The University of Alabama in Huntsville

The objective is to determine under what conditions (if any) surface tension driven convection can occur in closed containers. A liquid in space may not conform to the shape of its container. It may be possible for Marangoni convection to occur along all free surfaces of a liquid. If so, models of Marangoni convection effects on heat transfer and fluid motion in space must be refined. Two glass ampoules will be tested, one with water and one with silicone oil, both containing glass tracer beads. Each ampoule has a set of heaters and thermistors. The crew will record the onset of Marangoni convection during heating with video and the 35mm camera.

## **Smoldering Combustion in Microgravity (SCM)**

Dr. A. Carlos Fernandez-Pello  
University of California at Berkeley

The SCM experiment will study the smoldering characteristics of a polyurethane foam in environments with and without air flows. Specifically, the experiment will:

- Measure how different air flows and ignitor geometries affect the smolder propagation rates and the smolder temperatures.
- Measure the ignition energy required in low gravity as compared to Earth's gravity.
- Observe the potential transition from smoldering to flaming, the transition from smoldering to extinction and conditions leading to the transition.

Data gathered from the experiment will help scientists develop computer models of smoldering combustion processes and explore ways to control smoldering combustion in low gravity. Ultimately, this experiment will improve methods of fire prevention, detection and extinguishment aboard spacecraft and possibly on Earth.

## **Wire Insulation Flammability Experiment (WIF)**

Paul Greenberg  
NASA Lewis Research Center  
Cleveland, Ohio

The WIF experiment is designed to determine the offgassing, flammability and flame spread characteristics of overheated wire in a low gravity environment.

Extensive studies of the relationship between the electrical current passed through a wire and the heating of the wire have led to the development of building codes and insulation materials that minimize the number and severity of wiring-related fires. To support the development of similar "building codes" for future space-based structures, the WIF will study the warming of electrical wire in microgravity.

## **Candle Flames in Microgravity**

Dr. Howard Ross  
NASA Lewis Research Center  
Cleveland, Ohio

This experiment is expected to provide new insights into the combustion process. Specifically, this experiment is designed to:

- Determine if candle flames can be sustained in a purely diffusive, very still environment or in the presence of air flows smaller than those caused by buoyancy on Earth.

- Determine how the absence of buoyant convection affects the burning rate, flame shape and color of candle flames.
- Study the interactions between two closely spaced candles in microgravity.
- Determine if candle flames spontaneously oscillate before they go out in the absence of buoyancy-induced flows.

For the first test, the crew member will remove a candle and ignitor from the candle parts box and install them inside the glovebox. After making and verifying the electrical connections, the crew member will set up video cameras at the top and one side of the glovebox to focus on the area around the candle tip and the displays of thermocouple data.

After starting the camera and instruments, the crew member will activate the ignitor which will light the candle. Photography and temperature measurements will continue until the flame burns out or until a fixed period of time passes. The crew member then will turn on the glovebox fan to cool the candle box and replenish the glovebox with air. After about 1 minute, the next test can proceed. There will be a total of four tests conducted.

### **Fiber Pulling in Microgravity (FPM)**

Dr. Robert J. Naumann  
The University of Alabama in Huntsville

The objective is to test a variety of techniques to pull fibers in microgravity. On Earth, gravity drainage and Rayleigh-Taylor instabilities cause thin columns of low-viscosity liquids to break apart or form beads. In space, it should be possible to determine which of the two influences is the limiting factor in fiber pulling and whether certain low-viscosity materials could be more efficiently processed in microgravity. Simulated glass melts of different viscosities will be extruded from syringes to simulate the drawing of a fiber. The time for the breakage of the fibers will be determined. There are six syringe sets with decreasing ratios of viscosity to surface tension. One video camera will observe the apparatus, while the other camera will use a high resolution macro lens to focus on the pulled fibers.

### **Nucleation of Crystals from Solutions in a Low-g Environment (NCS)**

Dr. Roger L. Kroes  
NASA Marshall Space Flight Center  
Huntsville, Ala.

The objective is to test a new technique for initiating and controlling the nucleation of crystals from solution in reduced gravity. Improvements in the ability to control the location and time of the onset of nucleation of crystals in a solution have the potential to increase the flexibility of all space experiments involving solution crystal growth. A mildly supersaturated solution will be injected with a fixed amount of warmer solution in a crystal growth test cell. The injected solution will be more concentrated than the host solution and will initiate nucleation. The nucleation process will be recorded on the GBX video system. Solutions of triglycine sulfate, L-Arginine phosphate and potassium aluminium sulphate will

be tested. At the conclusion of each test, any crystals produced will be removed and stored for post-flight analysis.

### **Oscillatory Dynamics of Single Bubbles and Agglomeration in an Ultrasonic Sound Field in Microgravity (ODBA)**

Dr. Philip L. Marston  
Washington State University

The objective is to explore how large and small bubbles behave in space in response to an ultrasound stimulus. By understanding how the shape and behavior of bubbles in a liquid change in response to ultrasound, it may be possible to develop techniques that eliminate or counteract the complications that small bubbles cause during materials processing on Earth. A variety of bubble configurations will be tested in a sealed water chamber. An ultrasonic transducer will be attached to the chamber to establish an ultrasonic standing wave. The wave will drive the bubbles into shape oscillations. Bubbles will be brought into contact by either the ultrasonic field or direct mechanical manipulation. The coalescence and resulting decay of large amplitude shape oscillations will be recorded on video. The response of bubbles to a surfactant solution -- sodium dodecyl sulfate -- also will be tested.

### **Stability of a Double Float Zone (DFZ)**

Dr. Robert J. Naumann  
The University of Alabama in Huntsville

The objective is to determine if a solid cylinder can be supported by two liquid columns and remain stable in microgravity. It may be possible to increase the purity and efficiency of glass materials with a newly patented technique that relies on a solid column of material supported by two liquid columns of its own melt. If this arrangement can be maintained in microgravity, space may be a suitable laboratory for such processing. A variety of double float zone configurations will be tested using lexan rods of different sizes and with different end geometries. A center rod will be supported between two other rods by a float zone made of dyed water. The oscillations and breakup of the fluid as the two outer rods are moved will be recorded on video.

### **Oscillatory Thermocapillary Flow Experiment (OTFE)**

Dr. Simon Ostrach  
Case Western Reserve University

The objective is to determine the conditions for the onset of oscillations in thermocapillary flows in silicone oils. Temperature variations along a free surface generate thermocapillary flows in the bulk liquid. On Earth, the flows become oscillatory under certain conditions. By determining the conditions present when oscillations begin in microgravity and comparing them to oscillatory onset conditions on Earth, scientists will gain insight into the cause of the oscillations. Four cell/reservoir modules will be tested (two different sizes, using two different viscosities of silicone oil). Micron-sized aluminium

oxide tracer particles will be mixed with the fluid in the reservoir. The fluid will then be transferred to the test cell. The crew member manipulates the cell to obtain a fluid free surface. The fluid then is heated by a wire heating element in the center of the test cell. Three thermocouples measure the temperature at the wall, heater and in the fluid. Three video cameras will record the free surface behavior and the thermocouple readings.

### **Particle Dispersion Experiment (PDE)**

Dr. John R. Marshall  
NASA Ames Research Center  
Mountain View, Calif.

The PDE will determine the efficiency of air injection as a means of dispersing fine particles in a microgravity environment. The experiment will serve as a simple trial run for particle dispersion experiments in the Space Station Gas-Grain Simulation Facility. The dispersion particles also will be studied for their tendency to electrostatically aggregate into large clusters.

Electrostatic aggregation is an important process for cleansing planetary atmospheres after major dust storms, volcanic eruptions and meteorite/comet impact. Major biological/geological events such as the extinction of the dinosaurs have been attributed to the occlusion of sunlight by dust in the atmosphere after a meteorite impact. This climate effect depends on the time the dust stays aloft, which in turn depends upon the rate and mode of dust aggregation; hence the importance of understanding the nature of the aggregation process.

The PDE consists of a pump unit for generating compressed air and eight small experiment modules. An experiment involves connecting a module to the pump, pressurizing the pump by operation of a hand crank and sudden release of the compressed air into the module which forcefully injects a stream of small particles into the 2 x 2 x 2 inch cubic experiment volume of the module. The injection force disaggregates the particles and disperses them throughout the complete module volume. This process is filmed on video through one of two windows in the module. After this dispersion technique is tested, the particles will be monitored as they float freely in the experiment chamber and eventually aggregate into large clusters. The rapidity of aggregation and the mode of aggregation (sphere or chain formation) are of prime interest. This process is repeated for all modules. The eight modules allow for eight different tests that vary particle size and particle mass.

### **Directed Polymerization Apparatus (DPA): Directed Orientation of Polymerizing Collagen Fibers**

Dr. Louis S. Stodieck  
Center for Bioserve Space Technologies  
Colorado University, Boulder

This experiment is provided by the Center for Bioserve Space Technologies, a NASA Center for the Commercial Development of Space (CCDS) based at the University of Colorado, Boulder. The objective is to demonstrate that the orientation of collagen fiber polymers can be directed in microgravity in the absence of fluid mixing effects. Collagen

fibers have potential uses as synthetic implant materials. The orientation of collagen fiber polymers is critical to their functions, and gravity-driven mixing on Earth interferes with the ability to direct the orientation of these fibers. Collagen samples will be processed using a Directed Polymerization Apparatus. Eight samples will be activated on orbit in the GBX. Four will be subjected to weak electric currents to direct the orientation of the collagen fibers during assembly. Four samples will not be exposed to the current and will act as controls. After processing, the samples will be stored in a Refrigerator/Incubator Module.

### **Zeolite Glovebox Experiment (ZGE)**

Dr. Albert Sacco  
Worcester Polytechnic Institute

The Zeolite Crystal Growth experiment will be provided by the Battelle Advanced Materials Center, Columbus, Ohio, and the Clarkson Center for Commercial Crystal Growth in Space, Potsdam, New York, both of which are NASA Centers for the Commercial Development of Space (CCDS). The objective is to examine and evaluate mixing procedures and nozzle designs that will enhance the middeck Zeolite Crystal Growth experiment. Twelve self-contained, cylindrical, Plexiglas/Teflon™ autoclaves will be used to test three different mixer (nozzle) designs and four mixing protocols. Each autoclave is a sealed container containing silicate and aluminium solutions in separate volumes. The fluids are mixed by using a screwdriver to drive a piston into one volume, forcing the fluid through an opening to mix with the fluid in the second volume. Operations with the twelve autoclaves will be recorded on video.

## **SPACE ACCELERATION MEASUREMENT (SAMS)**

Principal Investigator:

Charles Baugher  
NASA Lewis Research Center  
Cleveland, Ohio

The Space Acceleration Measurement System (SAMS) is designed to measure and record low-level acceleration that the Spacelab experiences during typical on-orbit activities. The three SAMS sensor heads are mounted on or near experiments to measure the acceleration environment experienced by the research package. The signals from these sensors are amplified, filtered and converted to digital data before being stored on optical disks.

For the first USML-1 mission, the main unit of the Space Acceleration Measurement System will be mounted in the center aisle of the Spacelab module, near the aft end of the module. Its three remote sensor heads will be mounted on the Crystal Growth Furnace experiment, Surface Tension Driven Convection Experiment and the Glovebox Experiment Module.

SAMS flight hardware was designed and developed in-house by the NASA Lewis Research Center.

## **EXTENDED DURATION ORBITER MEDICAL PROJECT (EDOMP)**

Project Manager:

J. Travis Brown  
NASA Johnson Space Center, Houston

A series of medical investigations are included in the STS-50 flight plan to assist in the continuing development of countermeasures to combat adverse effects of space flight.

The upward shift of body fluids and slight muscle atrophy that occurs in space causes no problems while astronauts are in space. Researchers are concerned, however, that the readaptative processes occurring immediately upon return to Earth's gravity could hinder the crew in an emergency escape situation.

The Extended Duration Orbiter Medical Project, sponsored by the Johnson Space Center's Medical Science Division, will validate countermeasures for longer duration flights. EDOMP will have middeck investigations and pre- and post-flight investigations to assess the medical status of the crew following 13 days of exposure to microgravity. Three experiments selected for Spacelab use will involve Lower Body Negative Pressure, Variability of Heart Rate and Blood Pressure and a Microbial Air Sampler.

## **Lower Body Negative Pressure (LBNP)**

During early phases of a mission, observers notice that crew members' faces become puffy due to fluid shifting from the lower body toward the head and chest in the absence of gravity. While it is not a problem on orbit, the fluid shift and resultant fluid loss, although appropriate for microgravity, can pose potential problems upon return to Earth. Crew members may experience reduced blood flow to the brain when standing up. This could lead to fainting or dizziness. The investigators hypothesize that redistributing body fluids through exposure to Lower Body Negative Pressure in conjunction with fluid loading and salt tablets will improve this situation and help prevent fainting. The benefit is believed to remain in the body for 24 hours after the last treatment.

The LBNP experiment uses an inflatable cylinder which seals around the waist. The device is tethered to the floor of the Spacelab and stands 4 feet tall. A vent to the Spacelab vacuum is used to apply negative pressure to the device after the crew member is inside. The pressure is gradually decreased, drawing fluids to the lower body and somewhat offsetting the upward fluid shift that occurs upon entry to microgravity. A controller is used to automatically reduce and increase the pressure according to a preset protocol. Measurements of heart dimensions and function, heart rate and blood pressure will be recorded. Leg volume measurements will be performed before and after each protocol using the LBNP device. The data collected will be analyzed to determine the physiological changes in the crew members and the effectiveness of the treatment. The result of the procedure is expected to be an increased tolerance of orthostasis -- or standing upright -- upon return to Earth's gravity.

LBNP has been used a number of times in the U. S. space program, first during the Skylab missions. STS-50 will be the fourth flight of the current collapsible unit. Researchers are refining the LBNP protocol which will be used operationally on future 13-through 16-day missions.

## **Variable Heart Rate and Blood Pressure**

On Earth, many factors affect our heart rate and blood pressure. These include job stress, specific activity and diet. There are changes between our sleeping and waking states, known as diurnal variation. While emotions and normal body cycles cause a majority of these fluctuations, gravity plays a role. This study will determine if blood pressure and heart rate exhibit more or less variability in microgravity than on Earth. The study also will determine whether a change, if any, correlates with the reduction in sensitivity of baroreceptors in the carotid artery located in the neck. Baroreceptors are one of the body's blood pressure sensors used to regulate blood pressure and heart rate.

Crew members will wear portable equipment including an Automatic Blood Pressure Monitor and a Holter Recorder system that continuously records ECG while periodically monitoring blood pressure in the arm. The data collected are analyzed after the mission.

## **Microbial Air Sample**

Although all materials that go into the Shuttle are as clean as possible, bacteria and fungi growth have been detected in missions of 6-10 days duration. The growths were minimal and posed no health risk to the crew.

The microbial air sampler is a small device that will be placed in several areas of the Spacelab for air sampling. Agar strips will be inserted into the device for collection of microbes. Postflight analysis of the agar strips will quantify the fungal and bacterial growth from this 13-day mission.

## **Isolated/Stabilized Exercise Platform**

One of the major challenges faced in the STS-50/USML mission is the incompatibility of astronauts who need to perform vigorous exercise to maintain their health while at the same time sensitive microgravity experiments which need to be in an environment free from disturbances. The solution to this problem is a device called the Isolated/Stabilized Exercise Platform (ISEP) which supports the use of exercise equipment yet cancels out the inherent vibrations.

Lockheed designed the first ISEP for use with an ergometer, a stationary-cycle device built by the European Space Agency. Future designs will accommodate a treadmill and a rowing machine.

The ISEP consists of four rectangular stabilizers attached vertically to a frame, which rests on shock absorbers called isolators. The ergometer attaches to the frame. The stabilizers hold each corner of the frame stationary. A motor inside each stabilizer uses inertial stabilization to counteract the disturbances caused by exercise.

Without stabilizers, a crew member peddling a stationary bike can produce as much as 100 pounds of force, which far exceeds the allowable microgravity disturbance limits set by NASA. With the ISEP system, the exercise is expected to cause less than 1 pound of disturbance force on the Shuttle middeck.

## INVESTIGATIONS INTO POLYMER MEMBRANE PROCESSING

Principal Investigator:

Dr. Vince McGinness  
Battelle Advanced Materials Center, Columbus, Ohio

The Investigations into Polymer Membrane Processing (IPMP), a middeck payload, will make its seventh Space Shuttle flight for the Columbus, Ohio-based Battelle Advanced Materials Center, a NASA Center for the Commercial Development of Space, sponsored in part by the Office of Commercial Programs.

The objective of IPMP is to investigate the physical and chemical processes that occur during the formation of polymer membranes in microgravity such that the improved knowledge base can be applied to commercial membrane processing techniques. Supporting the overall program objective, the STS-50 mission will provide additional data on the polymer precipitation process.

Polymer membranes have been used by industry in separation processes for many years. Typical applications include enriching the oxygen content of air, desalination of water and kidney dialysis.

Polymer membranes frequently are made using a two-step process. A sample mixture of polymer and solvents is applied to a casting surface. The first step involves the evaporation of solvents from the mixture. In the second step, the remaining sample is immersed in a fluid (typically water) bath to precipitate the membrane, form the solution and complete the process.

On STS-50, a crew member will activate the IPMP experiment by sliding the stowage tray which contains two IPMP units to the edge of the locker. By turning each unit's valve to an initial position, the evaporation process is initiated. The evaporation process will last 5 minutes for one unit and 1 hour for the other. Subsequently, the units' valves will be turned to a second position, initiating a 15-minute precipitation process which includes quenching the membrane with water. Once the precipitation process is complete, the stowage tray will be slid back into the locker for the flight's duration.

Following the flight, the samples will be retrieved and returned to Battelle for testing. Portions of the samples will be sent to the CCDS's industry partners for quantitative evaluation consisting of comparisons of the membranes' permeability and selectivity characteristics with those of laboratory-produced membranes.

## **ORBITAL ACCELERATION RESEARCH EXPERIMENT (OARE)**

Principal Investigator:

Robert C. Blanchard  
NASA Langley Research Center, Hampton, Va.

The Orbital Acceleration Research Experiment (OARE) provides measurements of orbiter aerodynamic data within the thin atmosphere of extreme altitudes. Aerodynamic data is acquired on-orbit and during the high-altitude portion of atmospheric entry. The OARE instrument comprises a three-axis set of extremely sensitive linear accelerometers, which measure the vehicle's response to aerodynamic forces. These accelerometers are capable of measuring acceleration levels as small as one part per billion of Earth's gravity.

Because of their extreme measurement sensitivity, the OARE sensors cannot be adequately calibrated on the ground, in the presence of Earth's gravity. Consequently, the sensors are mounted on a rotary calibration table which enables an accurate instrument calibration to be performed on-orbit.

The OARE instrument is installed for flight at the bottom of the orbiter's payload bay on a special carrier plate attached to the orbiter's keel. OARE data are recorded both on the mission payload recorder and within the OARE's own solid-state memory for analysis after the flight.

## **SHUTTLE AMATEUR RADIO EXPERIMENT**

The Shuttle Amateur Radio Experiment (SAREX) is designed to demonstrate the feasibility of amateur shortwave radio contacts between the Space Shuttle and ground amateur radio operators, often called ham radio operators. SAREX also serves as an educational opportunity for schools around the world to learn about space first hand by speaking directly to astronauts aboard the Shuttle via ham radio. Contacts with certain schools are included in planning the mission.

Ham operators may communicate with the Shuttle using VHF FM voice transmissions, slow scan television and digital packet. Several selected ground stations also will be able to send standard television to the crew via SAREX. The television uplink will be used to send video of the crew's families and of the launch.

The primary voice frequencies to be used during STS-50 are 145.55 MHz for transmissions from the spacecraft to the ground and 144.95 MHz for transmissions from the ground to the spacecraft. Digital packet and slow scan television will operate on the same frequencies, while the television uplink will be limited to the UHF ham band at 450 MHz.

Equipment aboard Columbia will include a low-power, hand-held FM transceiver, spare batteries, headset, an antenna custom designed by NASA to fit in an orbiter window, interface module and an equipment cabinet.

SAREX has flown previously on Shuttle missions STS-9, STS-51F, STS-35, STS-37 and STS-45. SAREX is a joint effort by NASA, the American Radio Relay League (ARRL), the Amateur Radio Satellite Corp. and the Johnson Space Center Amateur Radio Club. Information about orbital elements, contact times, frequencies and crew operating times will be available from these groups during the mission and from amateur radio clubs at other NASA centers.

Ham operators from the JSC club will be operating on HF frequencies and the AARL (W1AW) will include SAREX information in its regular HF voice and teletype bulletins. The Goddard Space Flight Center Amateur Radio Club, Greenbelt, Md., will operate 24 hours a day during the mission, providing information on SAREX and retransmitting live Shuttle air-to-ground communications. In addition, the NASA Public Affairs Office at the Johnson Space Center will have a SAREX information desk during the mission.

### STS-45 SAREX Operating Frequencies

Location	Shuttle Transmission	Shuttle Reception
U.S., Africa	145.55 MHz	144.95 MHz
South America	145.55	144.97
and Asia	145.55	144.91
Europe	145.55 MHz	144.95 MHz
	145.55	144.75
	145.55	144.70

Goddard Amateur Radio Club Operations  
(SAREX information and Shuttle audio broadcasts)

3.860 MHz	7.185 MHz
14.295 MHz	21.395 MHz
28.395 MHz	

SAREX information also may be obtained from the Johnson Space Center computer bulletin board (JSC BBS), 8 N 1 1200 baud, at 713/483-2500 and then type 62511.

## **STS-50 PRELAUNCH PROCESSING**

Columbia arrived at KSC on Feb. 9, after a 6-month modification period at Rockwell International in Palmdale, Calif. Some of the major changes incorporated into the flagship orbiter will allow for extended duration missions up to 16 days.

Changes made to equip the orbiter for extended flights include adding an extended duration orbiter (EDO) pallet to meet additional power and water requirements, increasing the capacity of the waste collection system, installing the regenerative carbon dioxide removal system for removing carbon dioxide from the crew cabin atmosphere, installing two additional nitrogen tanks for the crew cabin atmosphere and augmenting the stowage space with extra middeck lockers.

Other systems on board Columbia now feature design changes or updates as part of continued improvements to the Space Shuttle. The upgrades include several improved or redesigned avionics systems, the drag chute and new beefed-up main gear tires that use a synthetic rubber tread instead of the natural rubber previously used.

While in the Orbiter Processing Facility (OPF), technicians installed the three main engines. Engine 2019 is in the No. 1 position, engine 2031 is in the No. 2 position and engine 2011 is in the No. 3 position.

After being readied for its 12th flight, Columbia was transferred out of the OPF on May 29th and towed several hundred yards to the Vehicle Assembly Building (VAB) and connected to its external tank and solid rocket boosters on the same day.

In the VAB technicians connected the 100-ton space plane to its already stacked solid rocket boosters and external tank. Columbia was scheduled to be transferred to pad 39-A the week of June 1.

The primary STS-50 payload, the U.S. Microgravity Laboratory-1, was installed in the OPF on April 13. An interface verification test between the orbiter and laboratory was completed.

In addition to the routine operations at the launch pad, a test is scheduled in which the orbiter's fuel cell storage tanks and extended duration orbiter pallet tanks will be loaded with liquid oxygen and liquid hydrogen reactants. This test will validate procedures and establish timelines to tank and detank the EDO pallet.

Also planned is the Terminal Countdown Demonstration Test with the STS-50 flight crew during the week of June 8.

A standard 43-hour launch countdown is scheduled to begin 3 days prior to launch. During the countdown, the orbiter's fuel cell storage tanks and extended duration orbiter pallet tanks will be loaded with fuel and oxidizer and all orbiter systems will be prepared for flight. The hold time will be extended to allow extra time for loading the EDO pallet with cryogenic propellants.

About 9 hours before launch, the external tank will be filled with its flight load of a half million gallons of liquid oxygen and liquid hydrogen propellants. About 2 1/2 hours before liftoff, the flight crew will begin taking their assigned seats in the crew cabin.

Columbia's end-of-mission landing is planned for Edwards Air Force Base, Calif. Columbia's landing will feature the drag chute. KSC's landing and recovery teams will be on hand to prepare the vehicle for the cross-country ferry flight back to Florida. Columbia's next flight, STS-52, is planned this fall with the LAGEOS II payload.

## **STS-50 CREW BIOGRAPHIES**

**Richard N. Richards**, 45, Capt., USN, will serve as Commander of STS-50. Selected as an astronaut in May 1980, Richards considers St. Louis, Mo., his hometown and will be making his third space flight.

Richards graduated from Riverview Gardens High School, St. Louis, in 1964; received a bachelor's in chemical engineering from the University of Missouri in 1969; and received a master's in aeronautical systems from the University of West Florida in 1970.

Richards first flew as Pilot of Shuttle mission STS-28, a Department of Defense-dedicated mission in August 1989. His next flight was as Commander of STS-41, a mission that deployed the Ulysses solar probe in October 1990. He has logged more than 219 hours in space.

**Kenneth D. Bowersox**, 36, Lt. Cmdr, USN, will serve as Pilot. Selected as an astronaut in June 1987, Bowersox considers Bedford, Ind., to be his hometown and will be making his first space flight.

Bowersox graduated from Bedford High School, Bedford, Ind.; received a bachelor's in aerospace engineering from the Naval Academy in 1978; and received a master's in mechanical engineering from Columbia University in 1979.

He was designated a naval aviator in 1981 and was assigned aboard the USS Enterprise, where he completed more than 300 carrier landings. In 1985, he graduated from the Air Force Test Pilot School and was assigned as the A-7E and F/A-18 test pilot at the Naval Weapon Center when selected by NASA. Bowersox has logged more than 2,000 hours flying time.

**Bonnie J. Dunbar**, 43, will serve as Mission Specialist 1 (MS1) and as Payload Commander. Selected as an astronaut in August 1981, she considers Sunnyside, Wash., to be her hometown and will be making her third space flight.

Dunbar graduated from Sunnyside High School, Sunnyside, Wash.; received a bachelor's and a master's in ceramic engineering from the University of Washington; and received a doctorate in biomedical engineering from the University of Houston.

Dunbar first flew on STS-61A, the Spacelab D-1 mission, in November 1985. Her next flight was on STS-32, the mission to retrieve the Long Duration Exposure Facility in January 1990. She has logged 430 hours in space.

**Ellen Baker**, 39, will serve as Mission Specialist 2 (MS2). Selected as an astronaut in May 1984, Baker considers New York, N.Y., to be her hometown and will be making her second space flight.

Baker graduated from Bayside High School in New York City; received a bachelor's degree in geology from the State University of New York; and received a doctorate of medicine from Cornell University.

Baker first flew on STS-34, a mission that deployed the Galileo probe to Jupiter in October 1989. She joined NASA in 1981 and served as a physician in the Flight Medicine Clinic until her selection as an astronaut. Baker has logged more than 119 hours in space.

**Carl J. Meade**, 41, Col., USAF, will serve as Mission Specialist 3 (MS3). Selected as an astronaut in June 1985, Meade considers Universal City, Texas., his hometown and will be making his second space flight.

Meade graduated from Randolph High School, Randolph Air Force Base, Texas.; received a bachelor's in electronics engineering from the University of Texas; and received a master's in electronics engineering from the California Institute of Technology.

Meade first flew on STS-38 in November 1990, a Department of Defense-dedicated Shuttle mission. He has logged more than 117 hours in space.

**Lawrence J. DeLucas**, 41, will serve as Payload Specialist 1 (PS1). DeLucas was born in Syracuse, N.Y., and will be making his first space flight.

DeLucas received a bachelor's and master's in chemistry from the University of Alabama at Birmingham; received a bachelor's in physiological optics from the University of Alabama at Birmingham; and received doctorates of optometry and biochemistry from the University of Alabama at Birmingham.

He has served as Associate Director of the Center for Macromolecular Crystallography at the University of Alabama since 1986; has been a member of the NASA Science Advisory Committee for Advanced Protein Crystal Growth since 1987; and is a professor in the University of Alabama's Department of Optometry. He also is a member of the graduate faculty at the University of Alabama.

**Eugene H. Trinh**, 41, will serve as Payload Specialist 2 (PS2). Trinh is a resident of Culver City, Calif., and will be making his first space flight. Trinh was born in Saigon, Vietnam, and was raised in Paris, France, since age 2. He has lived in the United States since 1968.

Trinh graduated from Lycee Michelet, Paris, with a baccalaureate degree; received a bachelor's in mechanical engineering-applied physics from Columbia University in 1972;

received a master's in applied physics from Yale University; and received a doctorate in applied physics from Yale.

Trinh's research work has focused on physical acoustics, fluid dynamics and containerless materials processing. He served as an alternate payload specialist for NASA for the Spacelab 3 mission in May 1985 and has developed several Shuttle flight experiments. He also is a member of the NASA Space Station Freedom Experiments planning group for Microgravity Science.

## **STS-50 MISSION MANAGEMENT**

### **NASA HEADQUARTERS, WASHINGTON, D. C.**

#### **Office of Space Flight**

Jeremiah Pearson	Associate Administrator
Thomas E. Utsman	Deputy Associate Administrator
Bryan O'Connor	Deputy Associate Administrator (Programs)
Leonard Nicholson	Director, Space Shuttle

#### **Office of Space Science and Applications**

Dr. Lennard A. Fisk	Associate Administrator
Alphonso V. Diaz	Deputy Associate Administrator
Robert C. Rhome	Director, Microgravity Science and Applications Division
Dr. Roger Crouch	USML-1 Program Scientist
Robert H. Benson	Director, Flight Systems Division
James McGuire	USML-1 Program Manager

#### **Office of Commercial Programs**

John G. Mannix	Assistant Administrator
Richard H. Ott	Director, Commercial Development Division
Garland C. Misener	Chief, Flight Requirements and Accommodations

### **AMES RESEARCH CENTER, MOUNTAIN VIEW, CALIF.**

Dr. Dale L. Compton	Director
Victor L. Peterson	Deputy Director
Dr. Steven A. Hawley	Associate Director
Dr. Joseph C. Sharp	Director, Space Research

## **AMES-DRYDEN FLIGHT RESEARCH FACILITY, EDWARDS, CALIF.**

Kenneth J. Szalai	Director
T. G. Ayers	Deputy Director
James R. Phelps	Chief, Space Support Office

## **KENNEDY SPACE CENTER, FLA.**

Robert L. Crippen	Director
James A. "Gene" Thomas	Deputy Director
Jay F. Honeycutt	Director, Shuttle Management and Operations
Robert B. Sieck	Launch Director
Bascom W. Murrah	Columbia Flow Director
J. Robert Lang	Director, Vehicle Engineering
Al J. Parrish	Director of Safety Reliability and Quality Assurance
John T. Conway	Director, Payload Management and Operations
P. Thomas Breakfield	Director, Shuttle Payload Operations
Joanne H. Morgan	Director, Payload Project Management
Russell D. Lunnen	STS-50 Payload Processing Manager

## **MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.**

Thomas J. Lee	Director
Dr. J. Wayne Littles	Deputy Director
Harry G. Craft	Manager, Payload Projects Office
Charles E. Sprinkle	USML Mission Manager
Dr. Donald O. Frazier	USML Mission Scientist
Alexander A. McCool	Manager, Shuttle Projects Office
Dr. George McDonough	Director, Science and Engineering
James H Ehl	Director, Safety and Mission Assurance
Otto Goetz	Manager, Space Shuttle Main Engine Project
Victor Keith Henson	Manager, Redesigned Solid Rocket Motor Project
Cary H. Rutland	Manager, Solid Rocket Booster Project
Gerald C. Ladner	Manager, External Tank Project

## **JOHNSON SPACE CENTER, HOUSTON**

Paul J. Weitz	Director (Acting)
Paul J. Weitz	Deputy Director
Daniel Germany	Manager, Orbiter and GFE Projects
Donald R. Puddy	Director, Flight Crew Operations
Eugene F. Kranz	Director, Mission Operations
Henry O. Pohl	Director, Engineering
Charles S. Harlan	Director, Safety, Reliability and Quality Assurance

## **STENNIS SPACE CENTER, BAY ST. LOUIS, MISS.**

Roy Estes	Director
Gerald Smith	Deputy Director
J. Harry Guin	Director, Propulsion Test Operations

# SHUTTLE FLIGHTS AS OF MAY 1992

47 TOTAL FLIGHTS OF THE  
SHUTTLE SYSTEM - 22 MISSIONS  
CONDUCTED SINCE RETURN TO  
FLIGHT.

14				
13				
12				
11				
10	STS 51-L 01/28/86	STS-40 06/05/91 - 06/14/91	STS-42 01/22/92 - 01/30/92	
09	STS 61-A 10/30/85 - 11/06/85	STS-35 12/02/90 - 12/10/90	STS-48 09/12/91 - 09/18/91	
08	STS 51-F 07/29/85 - 08/06/85	STS-32 01/09/90 - 01/20/90	STS-39 04/28/91 - 05/06/91	
07	STS 51-B 04/29/85 - 05/06/85	STS-28 08/08/89 - 08/13/89	STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92
06	STS 41-G 10/5/84 - 10/13/84	STS 61-C 01/12/86 - 01/18/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91
05	STS 41-C 04/06/84 - 04/13/84	STS-9 11/28/83 - 12/08/83	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91
04	STS 41-B 02/03/84 - 02/11/84	STS-5 11/11/82 - 11/16/82	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91
03	STS-8 08/30/83 - 09/05/83	STS-4 06/27/82 - 07/04/82	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90
02	STS-7 06/18/83 - 06/24/83	STS-3 03/22/82 - 03/30/82	STS 51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90
01	STS-6 04/04/83 - 04/09/83	STS-2 11/12/81 - 11/14/81	51-G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89
		STS-1 04/12/81 - 04/14/81	51-D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89
			STS 51-C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88
			STS 51-A 11/07/84 - 11/15/84	STS 61-B 11/26/85 - 12/03/85
			STS 41-D 08/30/84 - 09/04/84	STS 51-J 10/03/85 - 10/07/85
				STS-49 05/07/92 - 05/16/92
	OV-099 CHALLENGER	OV-102 COLUMBIA	OV-103 DISCOVERY	OV-104 ATLANTIS
				OV-105 ENDEAVOUR

# Columbia's Twelfth Mission -- USML-1

## STS-50 Launch Window

Launch Date	Launch Window Opens			Launch Window Closes			Duration
	GMT	EDT	CDT	GMT	EDT	CDT	
06/22/92	16:05	12:05 p.m.	11:05 a.m.	18:35	02:35 p.m.	01:35 p.m.	2 hrs 30 min
06/23/92	16:06	12:06 p.m.	11:06 a.m.	18:36	02:36 p.m.	01:36 p.m.	2 hrs 30 min
06/24/92	16:07	12:07 p.m.	11:07 a.m.	18:37	02:37 p.m.	01:37 p.m.	2 hrs 30 min
06/25/92	16:07	12:07 p.m.	11:07 a.m.	18:37	02:37 p.m.	01:37 p.m.	2 hrs 30 min
06/26/92	16:08	12:08 p.m.	11:08 a.m.	18:38	02:38 p.m.	01:38 p.m.	2 hrs 30 min
06/27/92	16:08	12:08 p.m.	11:08 a.m.	18:38	02:38 p.m.	01:38 p.m.	2 hrs 30 min
06/28/92	16:09	12:09 p.m.	11:09 a.m.	18:39	02:39 p.m.	01:39 p.m.	2 hrs 30 min
06/29/92	16:09	12:09 p.m.	11:09 a.m.	18:39	02:39 p.m.	01:39 p.m.	2 hrs 30 min
06/30/92	16:10	12:10 p.m.	11:10 a.m.	18:40	02:40 p.m.	01:40 p.m.	2 hrs 30 min
07/01/92	16:11	12:11 p.m.	11:11 a.m.	18:41	02:41 p.m.	01:41 p.m.	2 hrs 30 min
07/02/92	16:11	12:11 p.m.	11:11 a.m.	18:41	02:41 p.m.	01:41 p.m.	2 hrs 30 min
07/03/92	16:12	12:12 p.m.	11:12 a.m.	18:42	02:42 p.m.	01:42 p.m.	2 hrs 30 min
07/04/92	16:13	12:13 p.m.	11:13 a.m.	18:43	02:43 p.m.	01:43 p.m.	2 hrs 30 min
07/05/92	16:13	12:13 p.m.	11:13 a.m.	18:43	02:43 p.m.	01:43 p.m.	2 hrs 30 min
07/06/92	16:14	12:14 p.m.	11:14 a.m.	18:44	02:44 p.m.	01:44 p.m.	2 hrs 30 min
07/07/92	16:15	12:15 p.m.	11:15 a.m.	18:45	02:45 p.m.	01:45 p.m.	2 hrs 30 min
07/08/92	16:15	12:15 p.m.	11:15 a.m.	18:45	02:45 p.m.	01:45 p.m.	2 hrs 30 min
07/09/92	16:16	12:16 p.m.	11:16 a.m.	18:46	02:46 p.m.	01:46 p.m.	2 hrs 30 min

Note: Mission Duration is 12/20:28



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For Release

Mark Hess  
Headquarters, Washington, D.C.  
(Phone: 202/453-4164)

June 9, 1992

Lisa Malone  
Kennedy Space Center, Fla.  
(Phone: 407/867-2468)

## **STS-50 LAUNCH ADVISORY**

NASA will launch Space Shuttle Columbia on a 13 day mission on June 25, 1992. NASA officials selected the launch date at the conclusion of the Flight Readiness Review held today at the Kennedy Space Center, Fla.

Mission STS-50, planned to be the longest flight to date in the Shuttle program, will carry the United States Microgravity Laboratory-1 payload into orbit. A Spacelab long module will serve as an in-orbit laboratory for seven crewmembers and 31 experiments devoted to materials science, fluid physics, combustion science and biotechnology.

Columbia will be launched into a 184 statute mile circular orbit inclined 28.5 degrees to the Equator from Pad 39-A. The launch window on June 25 opens at 12:07 p.m. EDT and closes at 2:37 p.m. EDT. Columbia will end its mission with a landing at Dryden Flight Research Facility, Calif. The mission duration is planned for 12 days, 20 hours and 29 minutes.

Commanding the mission will be Richard Richards. Columbia's pilot will be Ken Bowersox. Mission specialists are Bonnie Dunbar, Ellen Baker, and Carl Meade. Payload specialists are Larry DeLucas and Gene Trinh.

-end-

For Release

Mark Hess/Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/453-8536)

June 10, 1992

Release: 92-83

## **Shuttle Management Reorganization Announced**

NASA Associate Administrator for Space Flight, Jeremiah W. Pearson, III, today announced that Thomas Utsman, currently Deputy Associate Administrator, Office of Space Flight, will become the Program Director for the Space Shuttle. He will be given responsibility for directing long-range Shuttle planning, Space Shuttle continuous improvement activities and overseeing efforts to reduce Shuttle operations costs while maintaining safety.

Program Manager, Space Shuttle, Leonard Nicholson will remain at the Johnson Space Center (JSC), Houston, where he will oversee the day to day management of the Space Shuttle program and the integration of the Shuttle and Space Station Freedom. Management of vehicle integration and launch processing will continue to be the responsibility of Nicholson's deputy, Brewster H. Shaw, at the Kennedy Space Center, Fla. (KSC).

"One of the main challenges for the Shuttle Director's office in the coming years will be to oversee the integration of the Shuttle and Space Station Freedom," said Pearson. "In light of that, it will be more efficient for the Shuttle Manager to be at JSC where personnel reside who are responsible for the mission operations for both Shuttle and station, as well as engineering and design support for both programs." Freedom will be carried up in 18 separate stages aboard the Space Shuttle and assembled in space. Assembly of the orbiting international research center will begin in late 1995.

Previously, the relocation of the Shuttle Program Director from NASA Headquarters to KSC required the transfer of some program management functions and would have involved the relocation of approximately 20 people. Under this revised organization, a limited set of functions will be transferred to support the Program Manager in the areas of configuration and data requirements, ground operations and project integration support and will involve approximately 10 people being relocated to KSC.

- end -

For Release

Drucella Andersen  
Headquarters, Washington, D.C.  
(Phone: 202/453-8613)

June 9, 1992

H. Keith Henry  
Langley Research Center, Hampton, Va.  
(Phone: 804/864-6120)

Jim Sahli  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205-544-0034)

RELEASE: 92-84

## **NASA UNDERWATER TESTS TO SIMULATE SPACE ANTENNA ASSEMBLY**

NASA engineers are preparing to do the first assembly of a large-scale, parabolic (double-curve) antenna in a huge water tank whose buoyancy lets researchers simulate working in the microgravity environment of space.

Some future space antennas will be too big to fit inside a space vehicle, so they will have to be assembled in Earth orbit from smaller panels attached to a supporting framework.

This month's tests in the Neutral Buoyancy Simulator at NASA's Marshall Space Flight Center, Huntsville, Ala., will help establish assembly times for such antennas, evaluate work procedures and task coordination and check the compatibility of the hardware itself.

The 50-foot dish to be used in the underwater study mimics the primary reflector of a new type of Earth-observation instrument. The dish surface is divided into 37 six-sided segments that will be mounted on a 315-piece support structure.

The pieces fit together to make a honeycomb-like surface pattern. On an orbiting satellite, the segments would form a precise reflector that could pick up electromagnetic energy radiated from Earth and distribute it to various sensors. The larger the dish surface, the more accurate the measurements become. NASA's Langley Research Center, Hampton, Va., leads the effort.

- more -

- 2 -

The underwater tests will include construction of the reflector support structure, attachment of seven reflector panels each about 7 feet in diameter and the removal and reconnection of a panel to simulate repair activities.

Space-suited engineers from Langley will play the role of astronauts working in Earth orbit. They will erect the truss structure from individual stick-like members by manually joining them with Langley-designed and developed quick-connect joints similar to hardware tested on the recent STS-49 Space Shuttle mission.

During the simulation, one "astronaut" will remove the truss members and joints from canisters, while the other assembles the pieces into the truss. After part of the truss has been built, the test subjects will reorient their foot restraints and attach a series of reflector segments.

The mockup will be assembled on a fixture anchored to the bottom of the water tank. The fixture will support and move the truss during its construction and position the engineers as they move the footpads.

Researchers estimate that it will take about 3 hours to build the reflector mockup. The experience gained during this test will lead to refinements in precision reflector hardware being developed at Langley Research Center. NASA also is working on ways to create large space antennas using deployable structures, as well as by robotic and robot-assisted assembly.

Scientists will use precision reflectors to study the structure and origin of the universe and to improve understanding of environmental and climatic changes occurring on Earth.

- end -

EDITORS NOTE: A 3/4" video clip (4:30 running time) is available to media representatives by calling 202/453-8594. Still photos to illustrate the release also are available, 202/453-8375.

COLOR:	B&W:
92-HC-349	92-H-395 through -398
92-HC-350	

Barbara E. Selby  
Headquarters, Washington, D.C.  
(Phone: 703/557-5609)

For Release  
June 10, 1992

James A. Richter  
National Center for Manufacturing Sciences, Inc.  
Ann Arbor, Mich.  
(Phone: 313/995-0300)

RELEASE: 92-85

## **TECHNOLOGY DEVELOPMENT AND TRANSFER PROGRAM ESTABLISHED**

Through a recent letter agreement, NASA and the National Center for Manufacturing Sciences, Inc. (NCMS), Ann Arbor, Mich., have established a continuing program for technology development and transfer between NASA and NCMS and its member companies to advance the state of U.S. manufacturing. NASA and NCMS have agreed to establish procedures and principles for research endeavors in the area of advanced manufacturing sciences.

NASA Administrator Daniel S. Goldin and NCMS President Edward A. Miller signed the agreement at the May 29 National Technology Initiative Conference in Pasadena, Calif. NASA and NCMS will establish a continuing program that emphasizes advancing manufacturing sciences and technologies which include energy-efficient and environmentally sound processes, tools, materials and techniques that improve the quality, reliability and competitiveness of U.S. manufactured products.

"Technology transfer has been an integral part of NASA for the past 30 years," said Goldin. "Through collaborative efforts with industry, NASA has contributed greatly to the U.S. economy by using its aerospace technology as the basis for tens of thousands of successful spinoff products and processes."

Cooperative efforts for this program will include information exchange in agreed-upon areas of cooperation, technical workshops to identify technology transfer opportunities, collaborative applications engineering projects to adapt NASA technology for use by the U.S. manufacturing industry and cooperative research and development.

- more -

- 2 -

NCMS President Miller called the agreement "a critical step on the road toward world-class manufacturing in the 21st century. "We are seeing a new spirit of collaboration in both the public and private sectors," he noted. "Partnerships combining the strengths of manufacturers, government entities and academic institutions are emerging on a number of fronts.

"These are partnerships that will not only help bolster the nation's position in world markets but also its economic stability here at home. With this agreement -- and others like it -- we are at the forefront of a new way of doing business in America," Miller said.

The program will be implemented by individual sub-agreements between NASA field centers and NCMS member companies. NCMS, a nonprofit corporation, is authorized to act on behalf of its member companies, which include over 150 large, medium and small U.S. manufacturing firms.

- end -

For Release

Drucella Andersen  
Headquarters, Washington, D.C.  
(Phone: 202/453-8613)

June 10, 1992

RELEASE: 92-86

## **X-30 NATIONAL AERO-SPACE PLANE MOCKUP ROLLS OUT**

Decked out in striking red, white and blue colors, a 50-foot-long X-30 National Aero-Space Plane (NASP) mockup rolled out of its hanger today in ceremonies at Mississippi State University, Starkville.

University students won the chance to build the one-third scale mockup in a nationwide competition sponsored by the NASP Joint Program Office, composed of NASA and DOD officials. NASP is a high-priority effort to create a flight research vehicle that will take off like an airplane, fly into Earth orbit and then return through the atmosphere for a runway landing.

"NASA appreciates the hard work and dedication of the Mississippi State students," said Vincent L. Rausch, NASP Director at NASA Headquarters, Washington, D.C. "The spirit and teamwork they showed in getting a quality X-30 mockup built on time reflects the same cooperation that we have among government, industry and universities in the program."

Forty-five students in Mississippi State's engineering program worked for 5 months to construct the 5000-pound mockup at the university's Raspet Flight Research Laboratory. Throughout the project, they had access to NASP program officials who advised them on technical aspects of the X-30's design. Mississippi State aerospace engineering professor Dr. George Bennett directed the students' efforts.

The subscale X-30 is made entirely of composite materials so that it can tolerate rain, hail and the other weather conditions that it may experience in outside displays. The spaceplane mockup will debut at the U.S. Air and Trade Show in Dayton, Ohio, June 16-21, 1992. Other stops scheduled in 1992 are the Experimental Aircraft Association Fly-In at Oshkosh, Wisc., July 31-Aug. 6 and the World Space Congress in Washington, D.C., Aug. 28-Sept. 5. It also will tour in 1993 and 1994.

- end -

Photos are available to the media by calling 202/453-8375.

Color: 92-HC-360, -361, -362

B&W: 92-H-408, -409, -410

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400



For Release

Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

June 11, 1992

CONTRACT AWARD: C92-5

## **NASA CONTRACTS FOR TRAVEL SERVICES**

NASA announced today the selection of four contractors to provide travel services for NASA installations as a result of recent competition. The firms selected were:

to serve:

Rightway Travel  
A Division of Worldwide Travel Services, Inc.  
Jackson, Miss.

Stennis Space Center

Four Seasons Travel, Inc.  
Huntsville, Ala.

Marshall Space Flight Center

All World Travel of Cocoa Beach  
Cocoa Beach, Fla.

Kennedy Space Center

Omega World Travel  
Falls Church, Va.

Headquarters  
Ames Research Center  
Goddard Space Flight Center  
Johnson Space Center  
Langley Research Center

Contracts resulting from this selection will be effective Aug. 30, 1992, and will involve approximately \$24 million in purchases of air travel service for official travel.

- end -



For Release

Paula Cleggett-Haleim  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

EMBARGOED Until  
June 11, Noon EDT

Jim Doyle  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 92-87

## **NASA SATELLITE FINDS EVIDENCE OF PLANETS AROUND NEARBY STARS**

Two astronomers at NASA's Jet Propulsion Laboratory, Pasadena, Calif., said today they have evidence of planets or other bodies around eight stars they have studied in a star-forming region of the Milky Way galaxy, 450 light years from Earth.

Drs. Kenneth Marsh and Michael J. Mahoney disclosed their findings in a presentation before a session of the American Astronomical Society meeting in Columbus, Ohio.

The scientists said their discovery of unseen companions around low-mass stars in the Taurus-Auriga region of the Milky Way resulted from the study of data from the Infrared Astronomy Satellite acquired in 1983 and data from ground-based observatories acquired mostly from 1981-1983.

Taurus-Auriga is a giant gas and dust cloud complex, further out from the center of the galaxy than Earth's solar system and is one of two star-forming regions near to Earth. The stars they studied are called T Tauri stars. They have about the same mass as the sun. T Tauri stars are believed to be young and are usually found in groups embedded in clouds of gas and dust.

Earth's solar system is believed to have formed similarly, with the planets accreting from the matter in the solar disc left over after the formation of the sun.

By looking in the infrared part of the spectrum at the variations of emissions from the T Tauri solar discs, Mahoney and Marsh said they found evidence of gaps indicating that a body had accreted and swept an orbit around a young star, forming a gap in the disc.

- more -

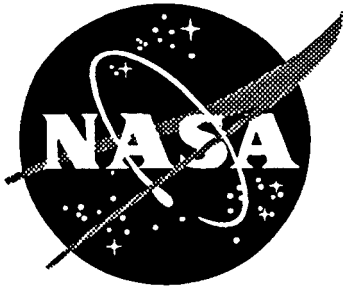
Eight such stars were identified. In some cases, wide gaps were found, suggesting a fairly massive companion such as a low-mass star or a brown dwarf. A brown dwarf is a body that might have become a sun if it had sufficient mass for nuclear reactions to begin in the core. For three stars, however, the gaps were much narrower, indicating much less massive companions which could be planets. These three stars were T Tauri, HK Tauri and UY Aurigae.

In looking at infrared emissions from the discs, Mahoney said, they also found that the dust temperatures at the outer gap boundaries were near -56 Fahrenheit, near the condensation temperature of water under interstellar conditions. "That is an important quantity in models of planet formation," Mahoney said.

Looking at gaps in the stellar discs is a new way of finding evidence of star companions, the scientists said. Previously astronomers looked at the perturbations of some stars, to see if the "wobble" of the stars could be caused by the gravitational influence of nearby bodies.

Marsh said that although the data they used also were studied by other scientists, they were more interested in star formation and were not looking for planets. "But we are in an environment where people are very interested in planets," he said.

A paper by the scientists, "Evidence for Unseen Companions Around T Tauri Stars," which describes their research, is to be published later this year in the Astrophysical Journal (Letters). The research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with NASA.

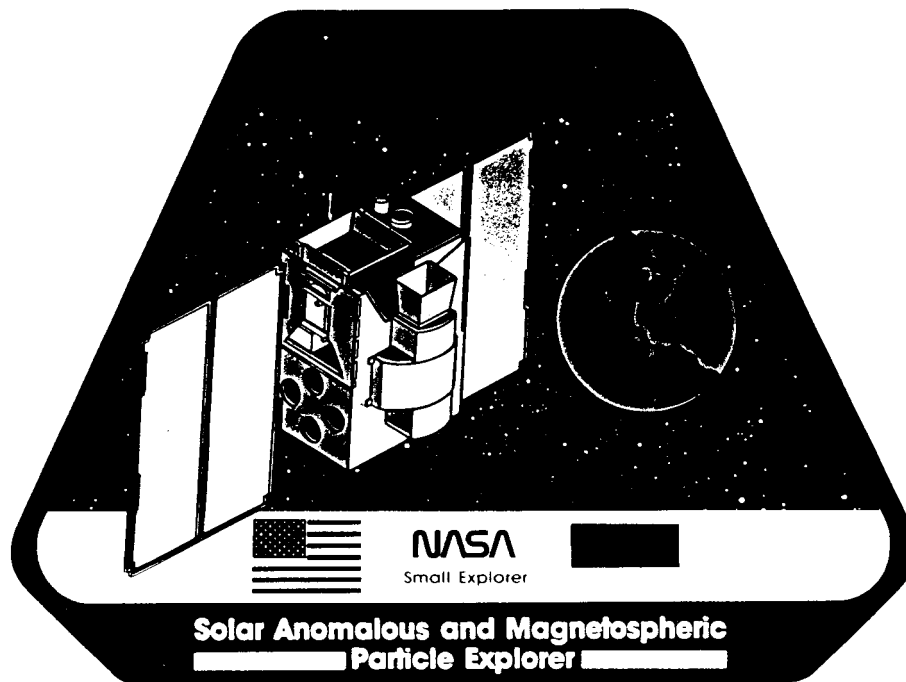


National Aeronautics  
and Space Administration

# SAMPEX

SOLAR, ANOMALOUS AND MAGNETOSPHERIC  
PARTICLE EXPLORER

## Press Kit



JUNE 1992

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## **PUBLIC AFFAIRS CONTACTS**

Paula Cleggett-Haleim  
Office of Space Science and Applications  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

Don Savage  
NASA Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

Dolores Beasley  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-2806)

Lisa Malone/Dick Young  
Kennedy Space Center, Fla.  
(Phone: 407/867-2468)

Jan Cooksey, KSC/VAFB  
Vandenberg Air Force Base, Calif.  
(Phone: 805/734-8232, ext. 53820)

Lt. Col. Tom Worsdale  
Vandenberg Air Force Base, Calif.  
30 SPW/PA  
(Phone: 805/734-8232, ext. 63595)

RELEASE: 92-88

## **SAMPEX MISSION TO STUDY ENERGETIC PARTICLES FROM SPACE**

NASA's Solar, Anomalous and Magnetospheric Particle Explorer (SAMPEX) satellite, an international collaboration with Germany, will contribute new information on the composition of energetic particles arriving at Earth from the solar atmosphere and interstellar space.

The satellite is scheduled for launch on a four-stage, Scout expendable launch vehicle from Vandenberg Air Force Base, Calif., on June 19, 1992. The launch window extends from 10:22 a.m. to 10:41 a.m. EDT. SAMPEX is designed to support a minimum mission duration of 1 year, with a potential mission lifetime of 3 or more years.

This small explorer carries a payload of four particle detectors and is designed to detect solar energetic particles, precipitating energetic electrons, anomalous cosmic rays and galactic cosmic rays. Determining the abundance of each element and the abundances of isotopes for many of the elements will enable scientists to learn more about the sun, the interplanetary environment and the interstellar environment. SAMPEX also will measure the number of relativistic electrons (at speeds just below the speed of light) that enter the Earth's atmosphere and contribute to the destruction of ozone.

SAMPEX was developed by the Small Explorer (SMEX) project at NASA's Goddard Space Flight Center, Greenbelt, Md., in just 3 years since the mission was initiated. SAMPEX, NASA's 68th Explorer mission, is the first in a series of small explorer missions that NASA began in 1989 to perform astrophysics and space physics investigations with satellites launched on small expendable launch vehicles. Two other small explorer missions are currently manifested: the Fast Auroral Snapshot Explorer, scheduled for launch in 1994, and the Submillimeter Wave Astronomy Satellite, which will be launched in 1995. An announcement of opportunity for other small explorer missions will be released later this year.

Dr. Glenn M. Mason, University of Maryland, College Park, is Principal Investigator for SAMPEX, and there are 10 co-investigators from American and German institutions. Gilberto Colón is Mission Manager, Dr. Daniel Baker is Project Scientist and Roberto Aleman is the SAMPEX Instrument Manager. All three are from the Goddard Space Flight Center, as is Orlando Figueroa, Project Manager for SMEX.

- end of general release -

## **SAMPEX SCIENCE OBJECTIVES**

While SAMPEX, with its four instruments, is expected to provide unprecedented detail about the composition of energetic particles from the Milky Way galaxy (galactic cosmic rays) and from the sun (solar energetic particles), the most dramatic, new results are expected to come from measuring the composition of "anomalous" cosmic rays. Anomalous cosmic rays are thought to be atoms of the local, interstellar gas that enter the solar system, are ionized and then accelerated to cosmic ray energies at the shock wave at the end of the solar wind.

At low latitudes, the Earth's magnetic field can turn back most charged, energetic particles before they reach the 342-statute mile to 419-statute mile altitude of SAMPEX's orbit. Nonetheless, SAMPEX's instruments are so sensitive that during the time spent near the Earth's north and south magnetic poles, SAMPEX will obtain 10 to 100 times more galactic cosmic rays and solar energetic particles than any previous mission.

More importantly, SAMPEX will be able to use the shielding power of the Earth's magnetic field at somewhat lower latitudes to discriminate energetic particles coming from the sun and the galaxy from anomalous cosmic rays. If the theory of anomalous cosmic rays is correct, the atoms should be only partially ionized and therefore, able to penetrate the Earth's magnetic field at lower latitudes. SAMPEX will confirm the theory if it observes anomalous cosmic rays at the lower latitudes and will tell scientists much more about the atoms as well. The possibility of directly measuring the composition of a sample of local interstellar matter in this way has very high scientific value.

## **SAMPEX INSTRUMENTS**

The SAMPEX mission will carry four scientific instruments: the Low Energy Ion Composition Analyzer, the Heavy Ion Large Telescope, the Mass Spectrometer Telescope and the Proton/Electron Telescope.

### **Low Energy Ion Composition Analyzer (LEICA)**

The LEICA instrument is a mass spectrometer that identifies incident mass and energy by simultaneously measuring the time-of-flight and residual kinetic energy of particles that enter the telescope and stop in one of four silicon, solid-state detectors. An earlier model of this instrument flew on the Space Shuttle in 1989 as a Get Away Special (GAS) experiment. LEICA is provided by the University of Maryland, College Park.

### **Heavy Ion Large Telescope (HILT)**

HILT will measure galactic cosmic rays and solar energetic particles when it is near the Earth's magnetic poles. In addition, this instrument is designed to determine the energy and elemental composition of anomalous cosmic rays at energies where they are most abundant. HILT will measure the direction, energy and charge of each nucleus from helium to nickel. HILT is provided by the Max Planck Institute for Extraterrestrial Physics in Garching, Germany. An earlier version of HILT also flew as a GAS experiment in 1989.

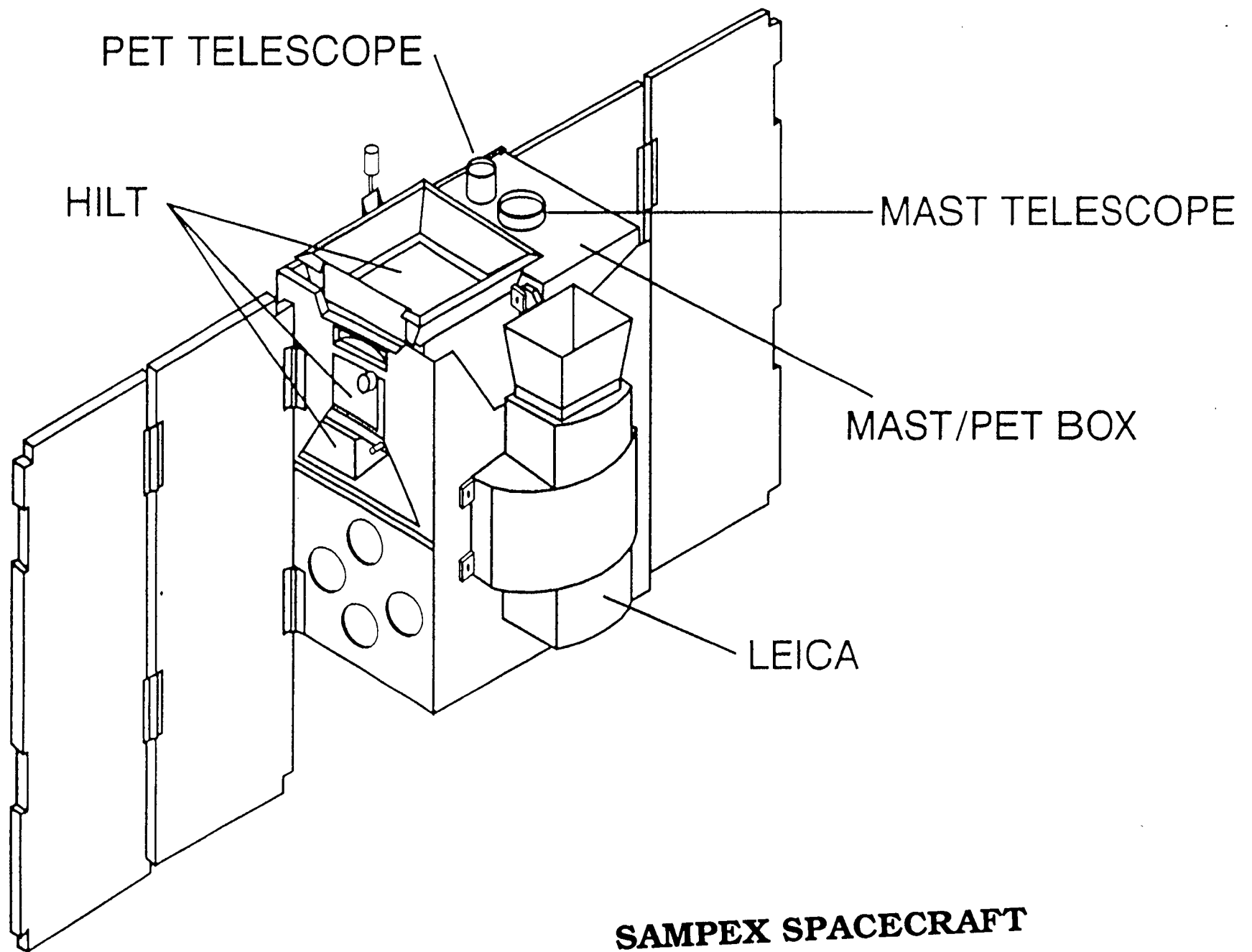
### **Mass Spectrometer Telescope (MAST)**

This instrument will determine the direction, energy, element and isotope of atoms from all elements up to nickel entering the instrument with velocities between about 12 percent and 75 percent of the speed of light. MAST is provided by the California Institute of Technology, Pasadena.

### **Proton/Electron Telescope (PET)**

The PET system is designed to complement MAST by measuring the energy of electrons, protons and helium nuclei coming from the Earth's radiation belts, the sun, interplanetary space and interstellar space. The electrons will be moving very close to the speed of light (186,000 miles per second) and could have a significant effect on the destruction of ozone high in the Earth's atmosphere. PET is provided by the California Institute of Technology and is housed in the same instrument box as MAST.

These four instruments were constructed at the separate institutions and integrated with a Data Processing Unit (DPU) provided by the Aerospace Corp. of El Segundo, Calif. The DPU is responsible for overall control of the science payload and controls instrument housekeeping functions.



**SAMPEX SPACECRAFT**

## **LAUNCH OPERATIONS**

The 8 hour, 10 minute launch countdown is scheduled to begin at 2:12 a.m. EDT on June 18. Included in the countdown is one built-in hold at the T minus 10 minute mark which extends from 10:02 to 10:12 a.m. EDT on June 19. Lift-off is scheduled for 10:22 a.m. EDT. The 19-minute launch window closes at 10:41 a.m. EDT.

Major tasks in the countdown include a communications check, activating the vehicle ground support equipment, check-out of the vehicle's electronic systems and fueling the reaction control system. In addition, the vehicle and launcher will be secured and erected, and a test of the ignition and destruct systems will be conducted. A weather briefing and a status of the countdown is held about 1 hour prior to launch.

A 24-hour turnaround can be supported depending on the nature of a launch postponement. In the event of a 24-hour scrub, the vehicle and spacecraft will be lowered from the launch platform and secured in the shelter at Space Launch Complex (SLC)-5.

About 90 seconds after launch at an altitude of about 24 nautical miles the second stage ignites and the first stage is separated from the vehicle. Next, the heat shield encapsulating the SAMPEX payload will be jettisoned at 2 minutes, 28 seconds after launch.

The third stage is ignited and the second stage is separated about 2 minutes, 30 seconds after launch. This burn lasts for approximately 48 seconds. The vehicle is oriented to the proper fourth stage attitude before spin up of the fourth stage which occurs about 10 minutes after launch when the vehicle is at an altitude of 300 nautical miles. Then, the third stage separates and performs a retromaneuver to move safely out of stage four's path. The fourth stage is ignited and burns for about 30 seconds. The Scout rocket delivers its payload into orbit about 15 minutes after launch.

## **DOWNRANGE LAUNCH SUPPORT**

Tracking station support to receive launch vehicle telemetry and data from the first three stages will be provided by NASA and Air Force telemetry stations. Fourth stage data will be provided by an Advanced Range Instrumentation Aircraft which is a modified C-135 aircraft and serves as an airborne tracking station.

## **SCOUT LAUNCH VEHICLE AND SAMPEX LAUNCH PREPARATIONS**

Kennedy Space Center (KSC), Fla., is responsible for the preparation and launch of the Scout launch vehicle which will loft the SAMPEX payload into orbit from NASA's Western Test Range at Vandenberg Air Force Base (VAFB), Calif. The Scout is a four-stage solid propellant unmanned launch vehicle that has a 98 percent success record over the last 20 years.

A team of 30 KSC employees rotate duty at Vandenberg so that five are on hand during the assembly of the Scout rocket and the payload at Vandenberg. The four rocket motors arrived at the west coast facility by truck during the period from February 18 to March 29, 1991 for a previous mission that was canceled. The motors were stored at VAFB until build-up commenced in early January 1992. Following the motor build-up, a series of vehicle systems tests were conducted March 12-27.

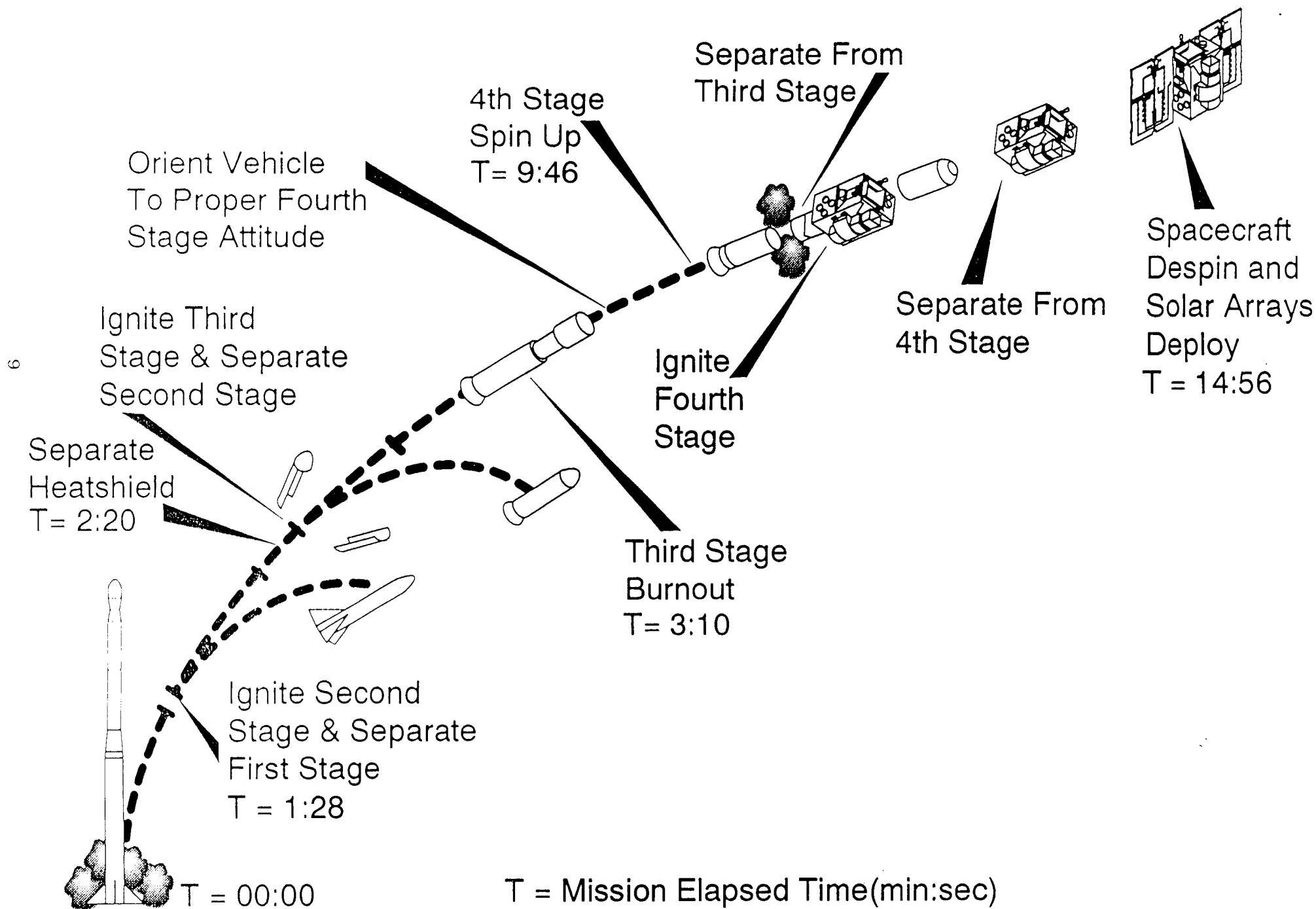
The vehicle was installed on the launcher at SLC-5, located at the VAFB south base, May 15-18. An electronic functional test was conducted May 20.

The SAMPEX payload arrived at Vandenberg by truck on May 20. It was transferred to the Dynamic Balance Facility on May 28 where it was mated to the fourth stage and went through static and dynamic balancing operations. The payload is scheduled to be transported to SLC-5 on June 5 where it will be attached to the Scout rocket.

The Scout program is managed by Goddard's Orbital Launch Services Project for NASA's Office of Space Science and Applications, Washington, D.C. From April 1959 to January 1991, Scout was managed by NASA's Langley Research Center, Scout Project Office, Hampton, Va.

## **SAMPEX MISSION TIMELINE**

<b>MET</b> <b><u>(MISSION ELAPSED TIME)</u></b>	<b><u>EVENT</u></b>
L-10:00:00	Spacecraft Closeout
L-08:10:00	Begin Countdown
L-04:55:00	Begin Scout Fueling
L-01:55:00	Power on Spacecraft, Begin Configuring Launch
L-00:04:30	Begin Spacecraft Terminal Phase (Switch to Internal Power, Final Telemetry Check)
L-00:02:00	Final Spacecraft Go/No Go
L+00:00:00	Scout Liftoff
L+00:01:24	First-Stage Burnout
L+00:01:28	First-Stage Separation and Second-Stage Ignition
L+00:02:09	Second-Stage Burnout
L+00:02:22	Third-Stage Ignition and Second-Stage Separation
L+00:03:10	Third-Stage Burnout
L+00:09:54	Third-Stage Separation
L+00:09:59	Fourth-Stage Ignition
L+00:10:32	Fourth-Stage Burnout
L+00:14:44	Spacecraft Separation
L+00:14:56	Solar Array Deployment
L+04:21:00	Initial Ground Station Pass (Madrid)



## **SCIENCE OPERATIONS**

The University of Maryland Science Operations Center (UMSOC), located in College Park, is responsible for all science operations. After NASA captures the data from the spacecraft, the UMSOC will receive the scientific data and distribute Level 1 data and line plots to all co-investigator institutions and the National Space Science Data Center at Goddard. Higher level science processing is carried out at the remote investigator sites.

## **SMALL EXPLORER DATA SYSTEM**

The SAMPEX control and data handling functions are performed by the Small Explorer Data System (SEDS). The SEDS provides on-board computers that can be programmed to perform mission unique functions as required and provides autonomous operation of the spacecraft when it is not in contact with the ground. The data system uses computer memory instead of more conventional tape recorders to record spacecraft telemetry data.

The management of the Mission Operations and Data Analysis phase of the SAMPEX mission will be transferred from the SMEX Project Office to the Orbiting Satellites Project Office within 30 days after launch. Both project offices are located at Goddard.

## **GROUND SEGMENT OPERATIONS**

Goddard's Wallops Flight Facility, Wallops Island, Va., is the primary ground station for communication with the spacecraft. Other ground stations are in Madrid, Spain; the Canberra Deep Space Tracking Station in Australia and the Goldstone Deep Space Tracking Station, Goldstone, Calif.

## **SMALL SPACE MISSIONS**

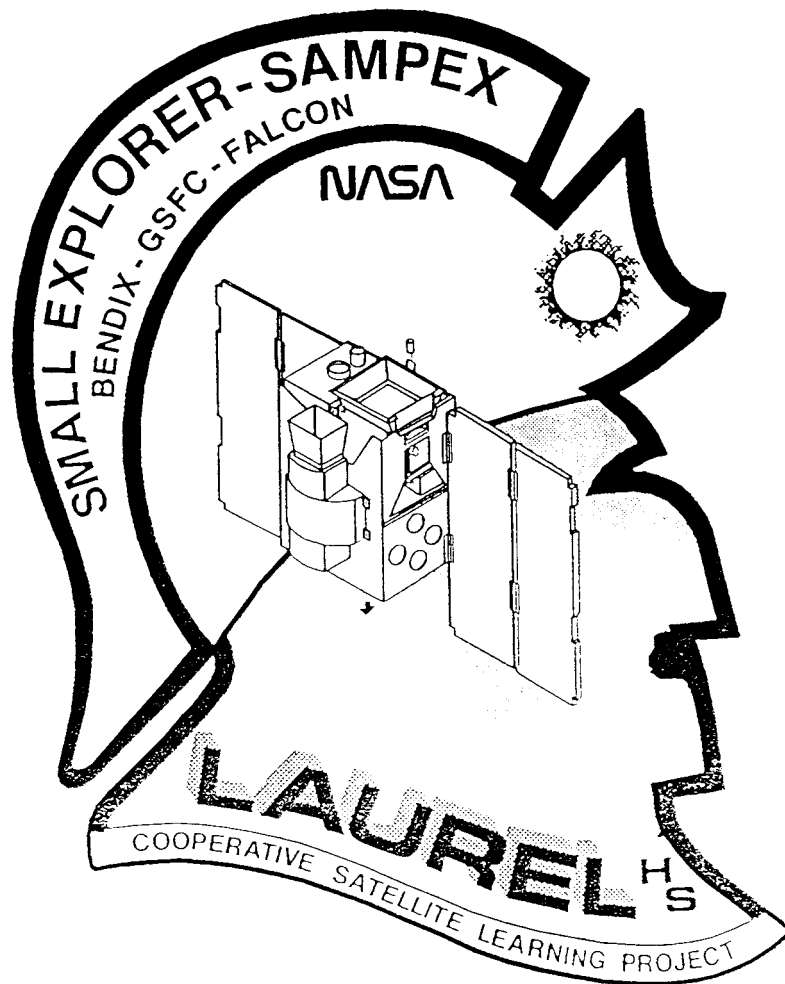
SAMPEX is the first in a series of small explorer missions initiated to address a number of important scientific problems using small scientific satellites in Earth orbit. The missions are relatively low cost, and NASA's goal is to launch one small explorer mission per year following a relatively short development time frame. The launch of SAMPEX comes just over 3 years since its inception in April 1989.

## COOPERATIVE SATELLITE LEARNING PROJECT

The Cooperative Satellite Learning Project is a unique educational partnership between Laurel High School, Laurel, Md.; Bendix Field Engineering Corp., Seabrook, Md.; Falcon Microsystems, Landover, Md.; and Goddard that involves high school students in the process of developing and operating SAMPEX.

This pilot program provides students with an understanding of the overall "end-to-end" system used to support SAMPEX and will demonstrate how NASA implements a specific mission for a given scientific endeavor. It also introduces the students to careers in space.

A Mission Monitor System in the high school will receive and process SAMPEX satellite data and provide computer-assisted tutoring. In this way, students will participate directly in SAMPEX tests, simulations and orbital operations.



## **SPACECRAFT SPECIFICS**

Payload:	Four particle detectors
SAMPEX Orbit:	342 x 419 statute miles
Orbit Inclination:	82 degrees
Weight:	348 pounds
Length:	4.5 feet stowed
Diameter:	2.8 feet stowed
Design Life:	3 years
Launch Vehicle:	Scout
Foreign Participation:	Max Planck Institute, Garching, Germany

## **PROGRAM RESPONSIBILITIES**

Spacecraft	Goddard Space Flight Center, Greenbelt, Md.
Science Operations	University of Maryland, College Park
Launch Operations	Kennedy Space Center, Fla.
Scout Launch Vehicle	Goddard Space Flight Center

## **SAMPEX CO-INVESTIGATORS**

Dr. D. Baker	Goddard Space Flight Center, Greenbelt, Md. Project Scientist
Dr. J. Blake	Aerospace Corp., El Segundo, Calif. Data Processing Unit
L. Callis	Langley Research Center, Hampton, Va. Data Analysis
Dr. D. Hamilton	University of Maryland, College Park, Md. LEICA
Dr. D. Hovestadt	Max Planck Institute, Garching, Germany HILT
Dr. B. Klecker	Max Planck Institute, Garching, Germany HILT
Dr. R. Mewaldt	Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif. MAST, PET
Dr. M. Scholer	Max Planck Institute, Garching, Germany HILT
Dr. E. Stone	California Institute of Technology, Pasadena, Calif. MAST, PET
Dr. T. Von Rosenvinge	Goddard Space Flight Center, Greenbelt, Md. MAST, PET

## **SAMPEX MISSION MANAGEMENT**

### **NASA HEADQUARTERS, WASHINGTON, D.C.**

Dr. Lennard A. Fisk	Associate Administrator, Office of Space Science and Applications
Alphonso V. Diaz	Deputy Associate Administrator, Office of Space Science and Applications
Dr. Dave Gilman	Program Manager
Dr. Vernon Jones	Program Scientist
Charles R. Gunn	Director, Expendable Launch Vehicle Division

### **GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.**

Dr. John Klineberg	Director, Goddard Space Flight Center
Peter T. Burr	Deputy Director, Goddard Space Flight Center
Orlando Figueroa	Project Manager
Dr. Dan Baker	Project Scientist
Gilberto Colón	SAMPEX Mission Manager

### **KENNEDY SPACE CENTER, FLA.**

Robert L. Crippen	Director, Kennedy Space Center
James A. "Gene" Thomas	Deputy Director, Kennedy Space Center
John T. Conway	Director, Payload Management and Operations
James L. Womack	Director, Expendable Vehicle Operations
George E. Looschen	Chief, Expendable Launch Vehicle Operations

### **UNIVERSITY OF MARYLAND, COLLEGE PARK**

Dr. Glenn Mason	Principal Investigator
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# NASA News



National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 453-8400

For Release

David W. Garrett  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

June 15, 1992

RELEASE: 92-89

## JENKINS LEAVES NASA TO DIRECT SENATE OFFICE

Dr. Harriett G. Jenkins, Assistant Administrator for Equal Opportunity Programs, has resigned her NASA position to become first Director of the newly established Office of Senate Fair Employment Practices. In that role, she will administer processes that review allegations of prohibited discrimination practices and will implement programs for the Senate to heighten awareness of employee rights in order to prevent violations from occurring. Opportunity Programs. In that position, she was responsible for helping NASA integrate its workforce and for ensuring equal opportunity in personnel transactions and in the use of NASA's resources.

Before being appointed to NASA in 1974, Jenkins was a consultant to the District of Columbia school system for the Response to Educational Needs Project for about 4 months, beginning in late 1973. Prior to that, she served for 19 years as a public school educator in Berkeley, Calif., entering as a teacher and rising through the ranks to vice-principal, principal and Director of Elementary Education before reaching the post of Assistant Superintendent for Instruction in 1971.

In 1977, Jenkins received NASA's highest award, the Distinguished Service Medal. Also during 1977, she chaired the Task Force on Equal Opportunity and Affirmative Action, one of nine task forces of the Personnel Management Project, which led to the Civil Service Reform Act. For this work, she received the Civil Service Commissioner's Award for Distinguished Service. Dr. Jenkins received the President's Distinguished Executive Award in 1983.

In 1986, Jenkins was elected to the National Academy of Public Administration and in 1987, she received the Black Engineer of the Year Award for Affirmative Action. In 1988, she received a second Distinguished Service Medal from NASA and in 1990, the Women in Aerospace Lifetime Achievement Award.

- end -



For Release

Terri Sindelar  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

June 16, 1992

RELEASE: 92-90

## **UNDERGRADUATES SHOW NASA ADVANCED DESIGN CONCEPTS**

University students and faculty from across the nation will present scenarios for missions to Mars and present plans for solar-powered and hypersonic aircraft to officials of NASA and the aerospace industry on June 16-18 at the Ramada Renaissance Techworld Hotel, Washington, D.C.

Presentations on such topics as the design of a supersonic executive transport plane and remotely piloted vehicles and the design of a mission and spacecraft to take astronauts back to the Moon, to Mars and beyond will be made by engineering design students from 41 universities in the NASA/Universities Space Research Association's Universities Advanced Design Program.

In its 8th year, the advanced design program originally was conceived by NASA to revive interest in design education. The result has been a symbiotic relationship that has encouraged students to study engineering design in courses where they gain experience working on potential "real-world" projects which, in turn, stimulates interest in aerospace engineering.

Each university design team will present the results of their design project, offer participants the opportunity to interact with each other and to share ideas. NASA and aerospace industry representatives will attend and critique the presentations.

Typically, seniors participate in the program by enrolling in an engineering design course taught by a professor who serves as faculty advisor and a graduate teaching assistant who has spent 10 weeks of the previous summer working at a NASA center or industry site preparing project plans and gaining experience.

Each design team is assigned to a NASA engineer who acts as its mentor. Mentors aid students in the selection of a project and offer advice and resources.

- end -



For Release

David W. Garrett  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

June 18, 1992  
Embargoed until  
6:00 p.m. EDT

RELEASE: 92-91

## **NASA RATIFIES FIRST CONTRACT WITH RUSSIAN SPACE PROGRAM**

NASA Administrator Daniel S. Goldin and Yuri Koptev, the Director General of the Russian Space Agency, today formally ratified the first contract between NASA and a Russian aerospace firm, NPO-Energia. The contract is for the study of applications of Russian space technology to the Space Station Freedom program.

The contract is for an initial period of 1 year with a value of \$1 million and will initially cover three general areas:

- o The possible use of the Russian Soyuz TM manned spacecraft and the Progress transport spacecraft in the Space Station Freedom program. Of immediate NASA interest is the potential applicability of the Soyuz craft as an interim Assured Crew Return Vehicle.
- o The possible use of a Russian automated rendezvous and docking system known as APAS. This system is now used with the Russian MIR space station currently in orbit and has the potential of serving as a universal docking system.
- o The possible use of the MIR space station for long lead-time life sciences experiments in support of the Space Station Freedom program.

The formal contract ratification follows a series of technical meetings and negotiations over the past 3 months between NASA officials and their Russian counterparts at NPO-Energia.

Located in a Moscow suburb known as Kaliningrad, NPO-Energia is a quasi-independent company of some 30,000 employees responsible for design and development of many of the key elements of the Russian manned space program. Its current Director is Yuri Semenov, the chief designer of the Russian Buran space shuttle.

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For Release

Bill Livingstone/David Garrett  
Headquarters, Washington, D.C.  
(Phone: 202/453-8400)

June 24, 1992

RELEASE 92-92

## **GOLDIN SAYS AMERICA NEEDS SPACE STATION FREEDOM NOW**

America needs a laboratory in space -- Space Station Freedom -- so scientists can learn how to protect the health of humans living and working for long periods in space and improve the quality of life on Earth, NASA Administrator Daniel S. Goldin said today in remarks before the National Space Club.

"We can light up the sky with the inspirational work of Space Station Freedom, or we can stand by and watch the greatest technological bonfire of the century if it's canceled.

"We've waited long enough. To keep the next generation of benefits from space flowing back to Earth, America must have a permanent presence in space.

"We need Space Station Freedom and we need it now," Goldin said.

Despite 30 years of space flight, Goldin said doctors still know very little about how the body reacts in space, since no NASA mission, except Skylab, has lasted more than 14 days. The data from Mir is woefully inadequate, because their research capabilities just aren't there.

"Before astronauts can live on the Moon, or travel to Mars, or even spend months in orbit, we need to find out how to counteract the debilitating effects of zero and partial gravity. And the only place to learn about operating for long periods in space is in space," Goldin emphasized.

In weightlessness, muscles deteriorate, there is a reduction of red and white blood cells, there is a loss of bone mass and sensory problems with integrating information.

"The rate of bone loss in space is ten times as great," Goldin said. "On Earth, we call this osteoporosis. Twenty-million American women suffer from it. Finding how to counteract it could bring relief to those women."

- more -

In a country that focuses all too often on the short term, NASA is the one of the few agencies dedicated to our future. About \$2 billion of NASA's budget is for the space station.

"Sounds like a lot until compared with the \$6.3 billion Americans spend on pet food each year, or the \$4.3 billion we spend on potato chips, or the \$1.4 billion for popcorn," Goldin added.

Every time America has gone to the frontier, we've brought back more than we could ever imagine, Goldin said.

"As NASA turns dreams into realities and makes science fiction into fact, it gives America reason to hope our future will be forever brighter than our past," Goldin said.

Goldin stated that Thursday's Shuttle launch, which contains first-class experiments to learn the molecular structure of viruses and diseases, illustrates the importance of Space Station Freedom.

"We'll be examining the structure of new drugs, blood cells, antibodies and enzymes that control bodily functions. One experiment will try to find out what makes bacteria resistant to penicillin, so scientists can make 'tougher' penicillin against infections," he said.

During Columbia's 13 days in orbit, NASA will grow "crystals" of proteins in the AIDS virus to understand the molecular structure. The protein is placed in a solution. Then through evaporation crystals form, which then are examined using X-rays (crystallography), which can reveal its three-dimensional molecular structure. Thirty-one different protein crystal experiments will be performed, along with dozens of other kinds of research.

"Researchers will grow crystals of the proteins in the AIDS virus and its antibody. By understanding their molecular structure, we hope to speed the search for drugs that will interrupt the virus's vicious cycle of destruction.

"The tidal wave of basic science that's waiting to be flown in space is what will let us live longer lives, in a cleaner environment, with a higher standard of living.

"The cutting-edge technology that comes from space research is what provides the new jobs and new industries of tomorrow," Goldin said.



For Release

**Drucella Andersen**  
Headquarters, Washington, D.C.  
(Phone: 202/453-8613)

**June 24, 1992**

**Brian Dunbar**  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

**Jim Doyle**  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 92-93

## **NEW NASA PLANETARY ROBOTIC ROVER SET TO DEBUT**

Robotics engineers and scientists at NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif., will demonstrate a new planetary lander and robotic rover at a specially-designed test site near the laboratory on June 26.

"Rocky IV" is a prototype of a mini-rover that may be launched to Mars in 1996 as part of the Mars Environmental Survey (MESUR) Pathfinder mission. The 16.5-pound testbed will let NASA researchers study how to integrate planetary lander functions and science instruments under conditions approximating those of a Mars mission.

The 11:00 a.m. PDT demonstration at the laboratory's Arroyo test site will be part of the commemoration of the 25th anniversary of NASA's Surveyor Project, which JPL managed. Five Surveyor spacecraft successfully landed and operated on the moon from May 1966 through January 1968 to pave the way for later missions by the Apollo astronauts.

"Rocky IV, having its own behavioral control system, will be integrated with a lander that has a camera system with increased computer-processing capabilities, two-way radio communications and a command set that will be operated by a ground controller," said Dr. Arthur Lane, rover development task manager at JPL.

Rocky IV is 24 inches long, 15 inches wide and 14 inches high. It travels on six 5-inch-diameter wheels made of strips of steel foil and cleats to provide traction.

-more-

Lane noted that the six-wheeled model is stable and mobile. "This arrangement is better adapted for the environment we think we will find on Mars," he said.

Each wheel hub has a motor and the front and rear wheels can both steer the rover. Rocky IV was designed that way so that if one wheel motor fails, there is more than enough strength in the remaining motors to move the vehicle. The rover's "rocker-bogey" suspension, which uses no springs, gives it a high degree of stability when rolling over uneven surfaces.

Rocky IV carries sensors that will help it avoid hazards such as cliffs, dropoffs and excessive tilt angles. It also has a visible-light spectrometer and a color camera, a chipper to remove the thin weathered coverings of rocks and a soft-sand scoop to take soil samples. The rover also can place a seismometer on the surface.

-end-

NOTE TO EDITORS: A photograph of the Rocky IV mini-rover is available to media by calling 202/453-8375.

Color: C-92-HC-388  
B&W: 92-H-436



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For Release

Jeff Vincent  
Headquarters, Washington, D.C.  
(Phone: 202/453-8369)

June 24, 1992

RELEASE: 92-94

## **KEY OFFICIALS DESIGNATED IN TWO HEADQUARTERS OFFICES**

NASA Administrator Daniel S. Goldin today announced the appointments of key personnel in the Office of Public Affairs and the Office of Equal Opportunity Programs.

Bill Livingstone, who joined NASA last month as Special Assistant for Communications, has been appointed Associate Administrator for Public Affairs. For the last 7 years, Livingstone served as Press Secretary for then U.S. Senator and now Governor Pete Wilson (R-Calif.). Livingstone succeeds William Sheehan, who will retire July 1. Sheehan came to NASA in May 1985 and has been on assignment with the International Media Fund for the last year.

Sue Mathis Richard will serve as Deputy Associate Administrator for Public Affairs. She joined NASA in this capacity in April 1990 and has been the acting head of Public Affairs throughout Sheehan's absence.

Goldin also named Lewin S. Warren as Acting Assistant Administrator for Equal Opportunity Programs. He has served as Deputy Assistant Administrator in this office since joining the agency in April 1980. Prior to his employment at NASA, he worked for 24 years with the Central Intelligence Agency, including service as that agency's first Deputy Director for Equal Employment Opportunity.

In addition, Oeola S. Hall was designated Acting Deputy Assistant Administrator for Equal Opportunity Programs. Hall has been with NASA for 18 years and has led the agency's Discrimination Complaints Division since 1978. She also has been a key member of NASA's Culture Climate and Practices Committee.

Dr. Harriett Jenkins recently resigned as head of NASA's Office of Equal Opportunity Programs to become the first Director of the Office of Senate Fair Employment Practices.

- end -

92-95



**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

**SPACE SHUTTLE MISSION**

**STS-46 PRESS KIT**



**JULY 1992**

## **PUBLIC AFFAIRS CONTACTS**

### **NASA Headquarters**

Office of Space Flight/Office of Space Systems Development

Mark Hess/Jim Cast/Ed Campion

(Phone: 202/453-8536)

Office of Space Science and Applications

Paula Cleggett-Haleim/Mike Braukus/Brian Dunbar

(Phone: 202/453-1547)

Office of Commercial Programs

Barbara Selby

(Phone: 703/557-5609)

Office of Aeronautics and Space Technology

Drucella Andersen/Les Dorr

(Phone: 202/453-2754)

Office of Safety & Mission Quality/Office of Space Communications

Dwayne Brown

(Phone: 202/453-8596)

### **Ames Research Center**

Jane Hutchison

(Phone: 415/604-4968)

### **Langley Research Center**

Jean Drummond Clough

(Phone: 804/864-6122)

### **Dryden Flight Research Facility**

Nancy Lovato

(Phone: 805/258-3448)

### **Lewis Research Center**

Mary Ann Peto

(Phone: 216/433-2899)

### **Goddard Space Flight Center**

Dolores Beasley

(Phone: 301/286-2806)

### **Marshall Space Flight Center**

Mike Simmons

(Phone: 205/544-6537)

### **Jet Propulsion Laboratory**

James Wilson

(Phone: 818/354-5011)

### **Stennis Space Center**

Myron Webb

(Phone: 601/688-3341)

### **Johnson Space Center**

James Hartsfield

(Phone: 713/483-5111)

### **Wallops Flight Center**

Keith Koehler

(Phone: 804/824-1579)

### **Kennedy Space Center**

Lisa Malone

(Phone: 407/867-2468)

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RELEASE: 92-95

## **49TH SHUTTLE FLIGHT TO TEST FEASIBILITY OF TETHERED SATELLITE**

Highlighting Shuttle mission STS-46 will be experiments involving a 12.5-mile-long tether connecting a satellite to the orbiter Atlantis, to demonstrate the feasibility of the technology for a variety of uses ranging from generating electrical power to researching the upper atmosphere.

During the mission the crew also will deploy the European Retrievable Carrier (EURECA-1) platform, which contains a series of experiments dealing with materials sciences, life sciences and radiobiology. The platform will remain in orbit for about 9 months before being retrieved during a later Shuttle mission.

"First and foremost, this is a mission of discovery," Thomas Stuart, Tethered Satellite System Program Manager said.

"It's the first time we've ever deployed a satellite on a long tether in space. This system is at the leading edge of scientific discovery and will give us a glimpse of space technologies of the future," he said.

STS-46 is scheduled for launch in late July. It will be the 12th flight for Atlantis, and is scheduled to last 6 days, 22 hours and 11 minutes, with a planned landing at Kennedy Space Center, Fla.

## **TETHERED SATELLITE SYSTEM**

The Tethered Satellite System-1 (TSS-1) -- a joint project of the United States and Italy under an agreement signed in 1984 -- consists of a satellite, a 1/10th inch diameter tether and a deployer in the Shuttle's cargo bay.

The 1,139 pound satellite was developed by the Italian Space Agency (ASI) and the tether and deployer system were developed by the U.S. The 12 main experiments were selected jointly by NASA and ASI.

"During this mission we're going to learn a great deal about how to safely operate a tether system," Stuart said. "We're going to demonstrate the feasibility of using a tether to generate electricity, as a propulsion system to power spacecraft and for studying the Earth's magnetic field and ionosphere."

When the tether is fully extended to its 12 1/2 mile length, the combination of the orbiter, tether and satellite combined will be the longest structure ever flown in space.

## **EURECA**

The crew will deploy the European Space Agency's (ESA) EURECA-1, which will then ascend to its operational orbit of 515 km using its own propulsion system. After 9 months it will be moved to a lower orbit for retrieval by another Shuttle in late April 1993. After its return to Earth it will be refurbished and equipped for its next mission.

Aboard EURECA-1 are 15 experiments devoted to researching the fields of material science, life sciences and radiobiology, all of which require a controlled microgravity environment. The experiments include:

- protein crystallization
- biological effects of space radiation
- measurements of fluids' critical points in microgravity
- measurements of solar irradiation
- solar/terrestrial relationship in aeronomy and climatology
- electric propulsion in space

Scientists participating in the investigations are from Belgium, Germany, Denmark, France, Italy, United Kingdom and The Netherlands.

EURECA-1 was built by the ESA and designed to be maintained during its long-term mission by ground controllers at ESA's Space Operations Centre (ESOC), Darmstadt, Germany.

## **ADDITIONAL PAYLOADS**

Additional payloads carried in Atlantis' cargo bay include the:

- Evaluation of Oxygen Interaction with Materials III (EOIM) experiment to study how oxygen molecules in low-Earth orbit affect materials that will be used to construct Space Station Freedom;

- Thermal Energy Management (TEMP 2A) experiment to test a new cooling method that may be used in future spacecraft;

- Consortium for Material Development in Space Complex Autonomous Payload experiment to study materials processing;

- Limited Duration Space Environment Candidate Materials Exposure experiments will explore materials processing methods in weightlessness;

- An IMAX camera will be in the payload bay to film various aspects of the mission for later IMAX productions.

Atlantis will be commanded by USAF Col. Loren Shriver, making his third Shuttle flight. Marine Corps Major Andy Allen will serve as pilot, making his first flight. Mission specialists will include Claude Nicollier, a European Space Agency astronaut making his first Shuttle flight; Marsha Ivins, making

her second Shuttle flight; Jeff Hoffman, making his third space flight; and Franklin Chang-Diaz, making his third space flight. Franco Malerba from the Italian Space Agency will be the payload specialist aboard Atlantis.

-end-

## **MEDIA SERVICES INFORMATION**

### **NASA Select Television Transmission**

NASA Select television is available on Satcom F-2R, Transponder 13, located at 72 degrees west longitude; frequency 3960.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for the mission briefings will be available during the mission at Kennedy Space Center, Fla; Marshall Space Flight Center, Huntsville; Ames-Dryden Flight Research Facility, Edwards, Calif.; Johnson Space Center, Houston, and NASA Headquarters, Washington, D.C. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is updated daily at noon Eastern time.

### **Status Reports**

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA news center.

### **Briefings**

A mission press briefing schedule will be issued prior to launch. During the mission, change-of-shift briefings by the off-going flight director and the science team will occur at least once per day. The updated NASA Select television schedule will indicate when mission briefings are planned.

## **STS-46 QUICK LOOK**

**Launch Date/Site:** July 21, 1992 - Kennedy Space Center, Fla., Pad 39B  
**Launch Window:** 9:48 a.m. - 12:18 p.m. EDT  
**Orbiter:** Atlantis (OV-104)  
**Orbit:** 230 n.m. x 230 n.m. (EURECA deploy)  
160 n.m. x 160 n.m. (TSS operations)  
128 n.m. x 128 n.m. (EOIM operations)  
**Landing Date/Time:** 7:57 a.m. EDT July 28, 1992  
**Primary Landing Site:** Kennedy Space Center, Fla.  
**Abort Landing Sites:** Return to Launch Site - Kennedy Space Center, Fla.  
Transoceanic Abort Landing - Banjul, The Gambia  
Alternates - Ben Guerir, Morocco; Moron, Spain  
Abort Once Around - Edwards Air Force Base, Calif.  
**Crew:** Loren Shriver, Commander  
Andy Allen, Pilot  
Claude Nicollier, Mission Specialist 1  
Marsha Ivins, Mission Specialist 2  
Jeff Hoffman, Mission Specialist 3  
Franklin Chang-Diaz, Mission Specialist 4  
Franco Malerba, Payload Specialist 1  
**Operational shifts:** Red team -- Ivins, Hoffman, Chang-Diaz  
Blue team -- Nicollier, Allen, Malerba  
**Cargo Bay Payloads:** TSS-1 (Tethered Satellite System-1)  
EURECA-1L (European Retrievable Carrier-1L)  
EOIM-III/TEMP 2A (Evaluation of Oxygen  
Integration with Materials/Thermal Management  
Processes)  
CONCAP II (Consortium for Materials Development  
in Space Complex Autonomous Payload)  
CONCAP III  
ICBC (IMAX Cargo Bay Camera)  
LDCE (Limited Duration Space Environment  
Candidate Materials Exposure)  
**Middeck Payloads:** AMOS (Air Force Maui Optical Site)  
PHCF (Pituitary Growth Hormone Cell Function)  
UVPI (Ultraviolet Plume Instrument)

## STS-46 SUMMARY OF MAJOR ACTIVITIES

### Blue Team Flight Day One:

Launch  
Orbit insertion (230 x 230 n.m.)  
TSS activation  
RMS checkout  
TSS deployer checkout  
EOIM/TEMP-2A activation

### Red Team Flight Day One

### Blue Flight Day Two:

EURECA deploy  
EURECA stationkeeping  
checkout

### Red Flight Day Two:

TEMP-2A operations  
Tether Optical Phenomenon (TOP)

### Blue Flight Day Three:

TOP checkout  
Supply water dump nozzle DTO  
TEMP-2A operations  
OMS-3 burn  
OMS-4 burn (160 x 160 n.m.)

### Red Flight Day Three:

TSS checkout/in-bay operations

### Blue Flight Day Four:

TSS in-bay operations

### Red Flight Day Four:

TSS deploy  
TEMP-2A operations

### Blue Flight Day Five:

TSS on station 1 (12.5 miles)

### Red Flight Day Five:

TSS retrieval to 1.5 miles  
TSS final retrieval  
TSS dock

### Blue Flight Day Six:

TSS safing  
TSS in-bay operations  
OMS-5 burn  
OMS-6 burn (128 x 128 nm)

### Red Flight Day Six:

EOIM/TEMP-2A operations

### Blue Flight Day Seven:

TSS science deactivation  
EOIM/TEMP-2A operations

### Red Flight Day Seven:

EOIM/TEMP-2A operations  
Flight Control Systems checkout  
Reaction Control System hot-fire

### Blue Flight Day Eight:

Cabin stow  
Deorbit preparations  
Entry and landing

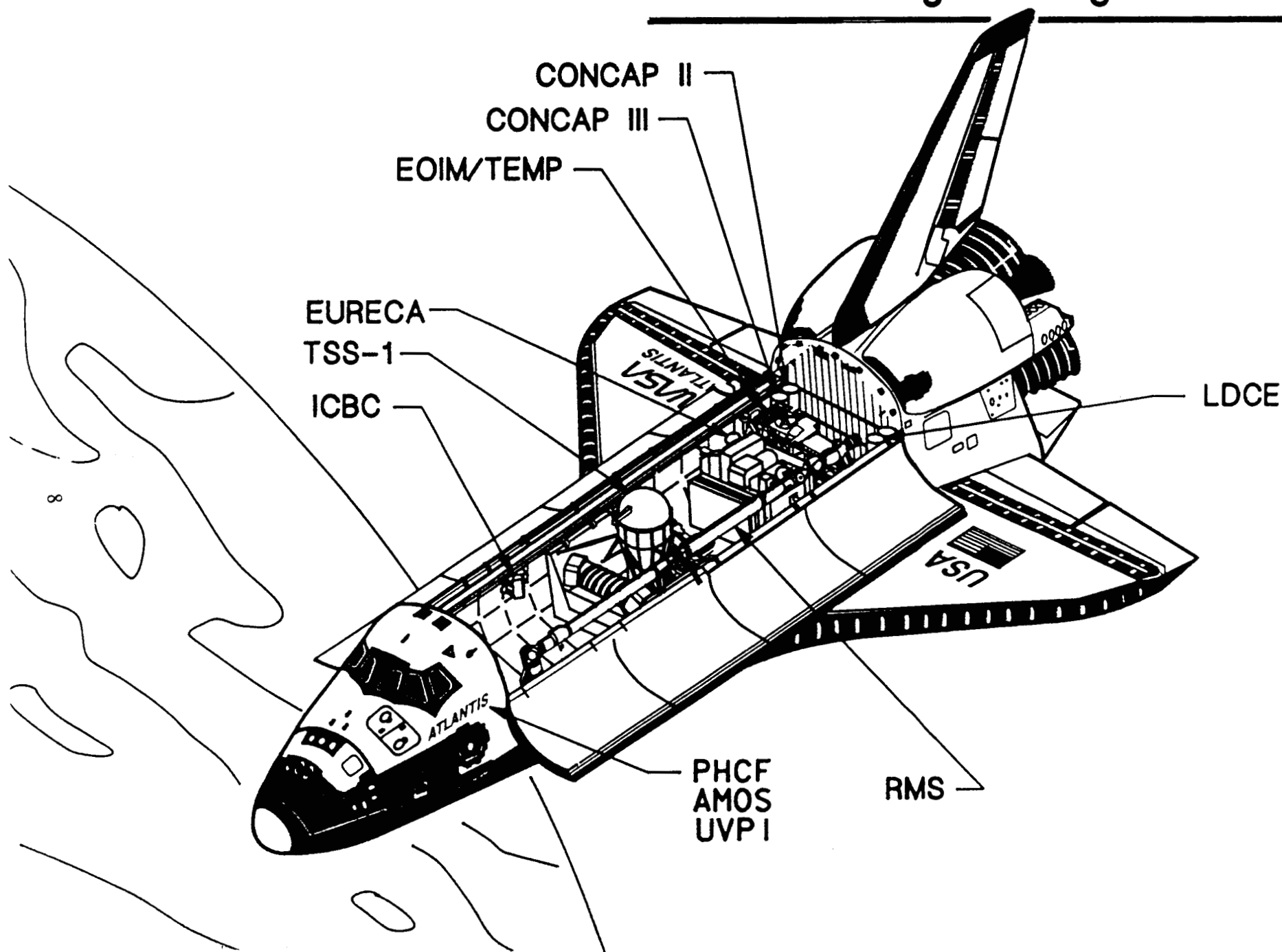
### Red Flight Day Eight:

## **STS-46 VEHICLE AND PAYLOAD WEIGHTS**

	Pounds
Orbiter (Atlantis) empty, and 3 SSMEs	151,377
Tethered Satellite -- pallet, support equipment	10,567
Tethered Satellite -- satellite, tether	1,200
European Retrievable Carrier	9,901
EURECA Support Equipment	414
Evaluation of Oxygen Interaction with Materials	2,485
CONCAP-II	590
CONCAP-III	368
LDCE	1,125
PHDF	69
Detailed Supplementary Objectives	56
Detailed Test Objectives	42
Total Vehicle at SRB Ignition	4,522,270
Orbiter Landing Weight	208,721

**NASA**

# Space Shuttle Program STS-46 Cargo Configuration



## STS-46 TRAJECTORY SEQUENCE OF EVENTS

EVENT	MET (d:h:m:s)	RELATIVE VELOCITY (fps)	MACH	ALTITUDE (ft)
Launch	00/00:00:00			
Begin Roll Maneuver	00/00:00:10	189	.16	797
End Roll Maneuver	00/00:00:15	325	.29	2,260
SSME Throttle Down to 80%	00/00:00:26	620	.55	6,937
SSME Throttle Down to 67%	00/00:00:53	1,236	1.20	28,748
SSME Throttle Up to 104%	00/00:01:02	1,481	1.52	37,307
Maximum Dynamic Press. (Max Q)	00/00:01:04	1,548	1.61	41,635
SRB Separation	00/00:02:04	4,221	4.04	152,519
Main Engine Cutoff (MECO)	00/00:08:29	24,625	22.74	364,351
Zero Thrust	00/00:08:35	24,624	N/A	363,730
ET Separation	00/00:08:48			
OMS-2 Burn	00/00:41:24			
Landing	06/22:11:00			

Apogee, Perigee at MECO: 226 x 32 nautical miles  
 Apogee, Perigee post-OMS 2: 230 x 230 nautical miles

## **SPACE SHUTTLE ABORT MODES**

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, orbiter and its payload. Abort modes include:

- \* Abort-To-Orbit (ATO) -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.

- \* Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit around before landing at either Edwards Air Force Base, Calif., White Sands Space Harbor, N.M., or the Shuttle Landing Facility (SLF) at the Kennedy Space Center, Fla.

- \* Trans-Atlantic Abort Landing (TAL) -- Loss of one or more main engines midway through powered flight would force a landing at either Banjul, The Gambia; Ben Guerir, Morocco; or Moron, Spain.

- \* Return-To-Launch-Site (RTL) -- Early shutdown of one or more engines, without enough energy to reach Ben Guerir, would result in a pitch around and thrust back toward KSC until within gliding distance of the SLF.

STS-46 contingency landing sites are Edwards Air Force Base, the Kennedy Space Center, White Sands Space Harbor, Banjul, Ben Guerir and Moron.

## **STS-46 PRE-LAUNCH PROCESSING**

KSC's processing team began readying the orbiter Atlantis for its 12th flight into space following its STS-45 flight that ended with a landing at KSC on April 2. Atlantis was in the Orbiter Processing Facility (OPF) from April 2 to June 4, undergoing post-flight inspections and pre-flight testing and inspections. While in the OPF, technicians installed the three main engines. Engine 2024 is in the No. 1 position, engine 2012 is in the No. 2 position and engine 2028 is in the No. 3 position.

The remote manipulator system was installed on Apr. 28. Members of the STS-46 flight crew participated in the Crew Equipment Interface Test on May 16.

Atlantis was towed from the Orbiter Processing Facility (OPF) on June 4 to the Vehicle Assembly Building where it was mated to its external tank and solid rocket boosters. Rollout to Launch Pad 39-B occurred on June 11, 1992. On June 15-16, the Terminal Countdown Demonstration Test with the STS-46 flight crew was conducted.

The Tethered Satellite System (TSS) was processed for flight in the Operations and Checkout Building high bay and the EURECA payload was processed at the commercial Astrotech facility in Titusville, Fla. The two primary payloads were installed in the payload canister at the Vertical Processing Facility before they were transferred to the launch pad.

Payload installation into Atlantis' payload bay was accomplished July 8. Several interface verification tests were scheduled between the orbiter and the payload elements. A standard 43-hour launch countdown is scheduled to begin 3 days prior to launch. During the countdown, the orbiter's fuel cell storage tanks will be loaded with fuel and oxidizer and all orbiter systems will be prepared for flight.

About 9 hours before launch, the external tank will be filled with its flight load of a half million gallons of liquid oxygen and liquid hydrogen propellants. About 2 and one-half hours before liftoff, the flight crew will begin taking their assigned seats in the crew cabin.

Atlantis's end-of-mission landing is planned at Kennedy Space Center. Several hours after landing, the vehicle will be towed to the Vehicle Assembly Building for a few weeks until an OPF bay becomes available. Atlantis will be taken out of flight status for several months for a planned modification period. Atlantis' systems will be inspected and improved to bring the orbiter up to par with the rest of the Shuttle fleet.

Atlantis's next flight, STS-57, is planned next year with the first flight of the Spacehab payload and the retrieval of the EURECA payload deployed on the STS-46 mission.

## **TETHERED SATELLITE SYSTEM (TSS-1)**

An exciting new capability for probing the space environment and conducting experiments will be demonstrated for the first time when the NASA/Italian Space Agency Tethered Satellite System (TSS-1) is deployed during the STS-46 Space Shuttle flight.

The Tethered Satellite System is made up of a satellite attached to the Shuttle orbiter by a super strong cord that will be reeled into space from the Shuttle's cargo bay. When the satellite on its cord, or tether, is deployed to about 12 miles above the orbiter, TSS-1 will be the longest structure ever flown in space.

For the TSS-1 mission, the tether -- which looks like a 12-mile-long white bootlace -- will have electrically-conducting metal strands in its core.

The conducting tether will generate electrical currents at a high voltage by the same basic principle as a standard electrical generator -- by converting mechanical energy (the Shuttle's more than 17,000-mile-an-hour orbital motion) into electrical energy by passing a conductor through a magnetic field (the Earth's magnetic field lines).

TSS-1 scientific instruments, mounted in the Shuttle cargo bay, the middeck and on the satellite, will allow scientists to examine the electrodynamics of the conducting tether system, as well as clarify their understanding of physical processes in the ionized plasma of the near-Earth space environment.

The TSS-1 mission will be the first step toward several potential future uses for tethers in space now being evaluated by scientists and engineers. One possible application is using long conducting tethers to generate electrical power for Space Station Freedom or other orbiting bodies.

Conversely, by expending electrical power to reverse the current flow into a tether, the system could be placed in an "electric motor" mode to generate thrust for orbit maintenance. Tethers also may be used to raise or lower spacecraft orbits. This could be achieved by releasing a tethered body from a primary spacecraft, thereby transferring momentum (and imparting motion) to the spacecraft. Another potential application is the creation of artificial gravity by rotating two or more masses on a tether, much like a set of bolas.

Downward deployment (toward Earth) could place a satellite in regions of the atmosphere that have been difficult to study because they lie above the range of high-altitude balloons and below the minimum altitude of free-flying satellites. Deploying a tethered satellite downward from the Shuttle also could make possible aerodynamic and wind tunnel type testing in the region 50 to 75 nautical miles above the Earth.

## **Mission Objectives**

Space-based tethers have been studied theoretically since early in this century. The first practical application of a shuttle-based tether was developed by Dr. Mario Grossi, Smithsonian Institution, in the early 1970s. Professor Guiseppe Colombo, University of Padova, Italy, subsequently proved the dynamic feasibility of the tether concept and suggested various uses. More recently, the projected performance of such systems has been modeled extensively on computers.

In 1984, the growing interest in tethered system experiments resulted in the signing of an agreement between NASA and the Italian Space Agency (Agenzia Spaziale Italiana - ASI) to jointly pursue the definition and development of a Tethered Satellite System to fly aboard the Space Shuttle. Scientific investigations (including hardware experiments) were selected in 1985 in response to a joint NASA/ASI announcement of opportunity.

The TSS-1 mission will be the first time such a large, electrodynamic tethered system has ever been flown. In many respects, the mission is like the first test flight of a new airplane: the lessons learned will improve both scientific theory and operations for future tether missions.

The mission objectives are to evaluate the capability for safely deploying, controlling and retrieving a tethered satellite; to validate predictions of the dynamic forces at work in a tethered satellite system; to conduct exploratory electrodynamic science investigations; and to demonstrate the capability of the system to serve as a facility for research in geophysical and space physics.

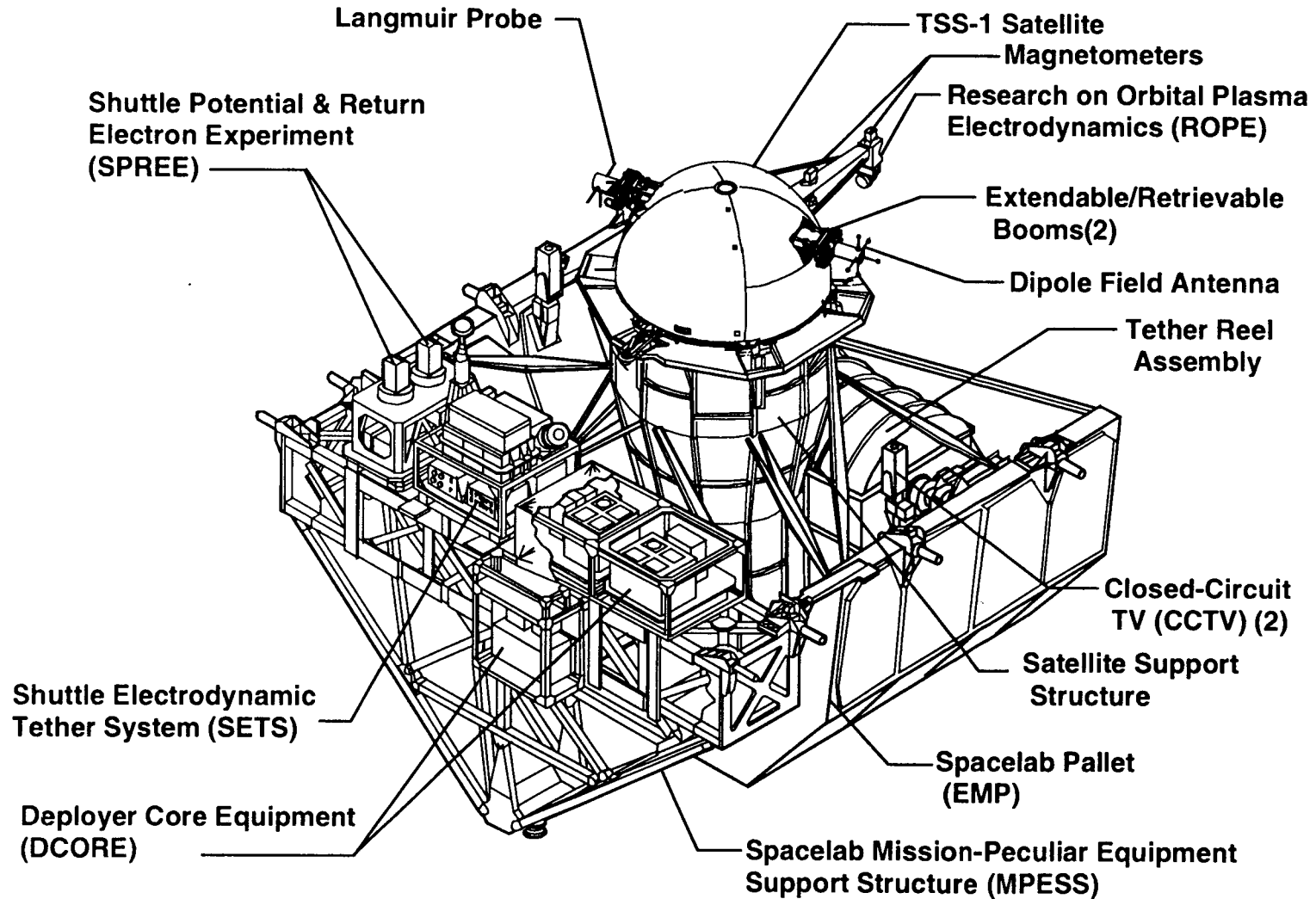
Since the dynamics of the Tethered Satellite System are complex and only can be tested fully in orbit, it is impossible to predict before the mission exactly how the system will perform in the space environment. In particular, retrieval and recapture present the greatest uncertainties.

Though tether system dynamics have been extensively tested and simulated, it could be that actual dynamics will differ somewhat from predictions. The complexity of a widely separated, multi-component system and the forces created by the flow of current through the system are other variables that will affect the system's performance.

## **Responsibilities**

Responsibility for Tethered Satellite System activities within NASA is divided between the Marshall Space Flight Center, Huntsville, Ala., and the Johnson Space Center, Houston. Marshall has the development and integration responsibility. Marshall also is responsible for developing and executing the TSS-1 science mission, and science teams for each of the 12 experiments work under that center's direction. During the mission, Johnson will be responsible for the operation of the TSS-1 payload. This includes deployment and retrieval of the satellite by the crew as well as controlling the satellite's motion in orbit and monitoring the state of the

# Shuttle Tethered Satellite System



Spacelab pallet, the deployer and the satellite. Marshall will furnish real-time engineering support for the TSS-1 system components and tether dynamics. The ASI responsibility for the TSS system is the development of the tethered satellite, the Italian onboard experiments and the Core equipment. In addition, ASI is providing satellite/Core equipment engineering support during the mission. All remote commanding of science instruments aboard the satellite and deployer will be executed by a Marshall payload operations control cadre stationed at Johnson for the mission.

## **Tethered Satellite System Hardware**

The Tethered Satellite System has five major components: the deployer system, the tether, the satellite, the carriers on which the system is mounted and the science instruments. Under the 1984 memorandum of understanding, the Italian Space Agency agreed to provide the satellite and NASA agreed to furnish the deployer system and tether. The carriers are specially adapted Spacelab equipment, and the science instruments were developed by various universities, government agencies and companies in the United States and Italy.

### **Carriers**

TSS-1 hardware rides on two carriers in the Shuttle cargo bay. The deployer is mounted on a Spacelab Enhanced Multiplexer-Demultiplexer pallet, a general-purpose unpressurized platform equipped to provide structural support to the deployer, as well as temperature control, power distribution and command and data transmission capabilities. The second carrier is the Mission Peculiar Equipment Support Structure, an inverted A-frame truss located immediately aft of the enhanced pallet. The support structure, also Spacelab-provided, holds science support equipment and two of the TSS-1 science experiments.

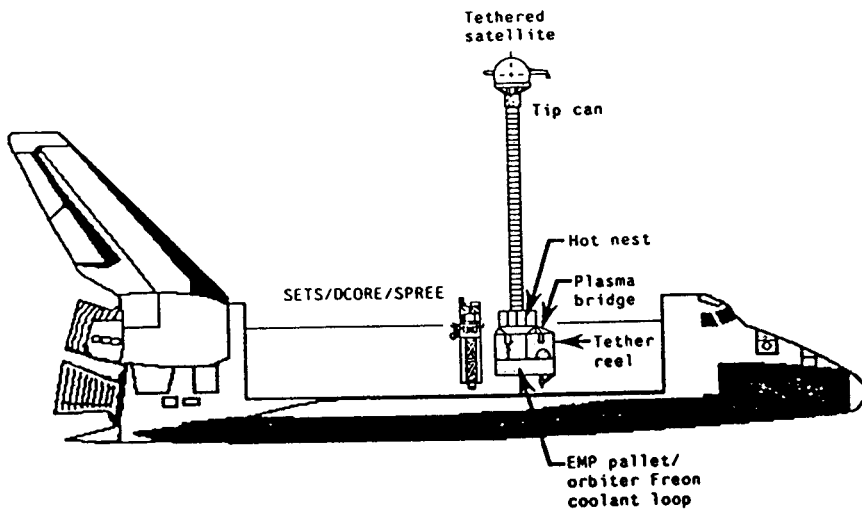
### **Deployer**

The deployer system includes the structure supporting the satellite, the deployment boom, which initially lifts the satellite away from the orbiter, the tether reel, a system that distributes power to the satellite before deployment and a data acquisition and control assembly.

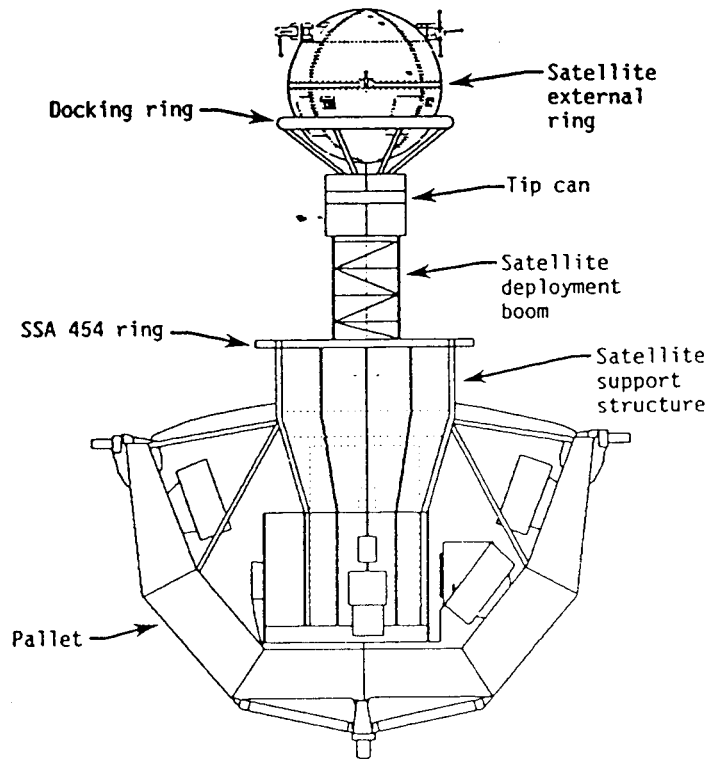
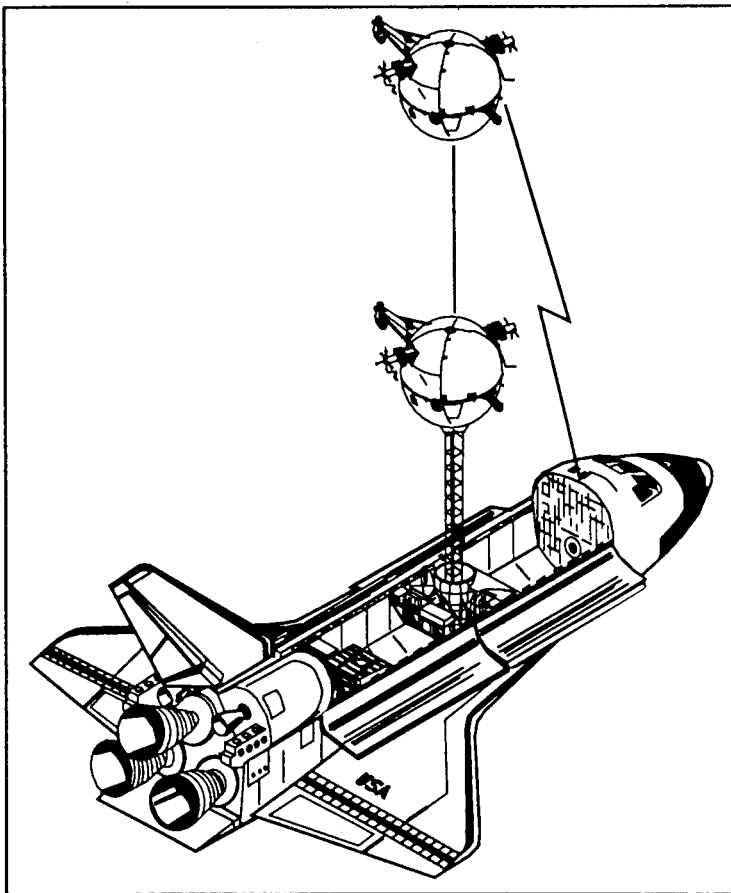
Cables woven through the structure provide power and data links to the satellite until it is readied for release. When the cables are disconnected after checkout, the satellite operates on its internal battery power.

The boom, with the satellite resting atop it, is housed in a canister in the lower section of the satellite support structure. As deployment begins, the boom will unfold and extend slowly out of the turning canister, like a bolt being forced upward by a rotating nut. As the upward part of the canister rotates, horizontal cross members (fiberglass battens similar to those that give strength to sails) are unfolded from their bent-in-half positions to hold the vertical members (longerons) erect. Additional strength is provided by diagonal tension cables. The process is reversed for retrieval. When it is fully extended, the 40-foot boom resembles a short broadcasting tower.

# TSS

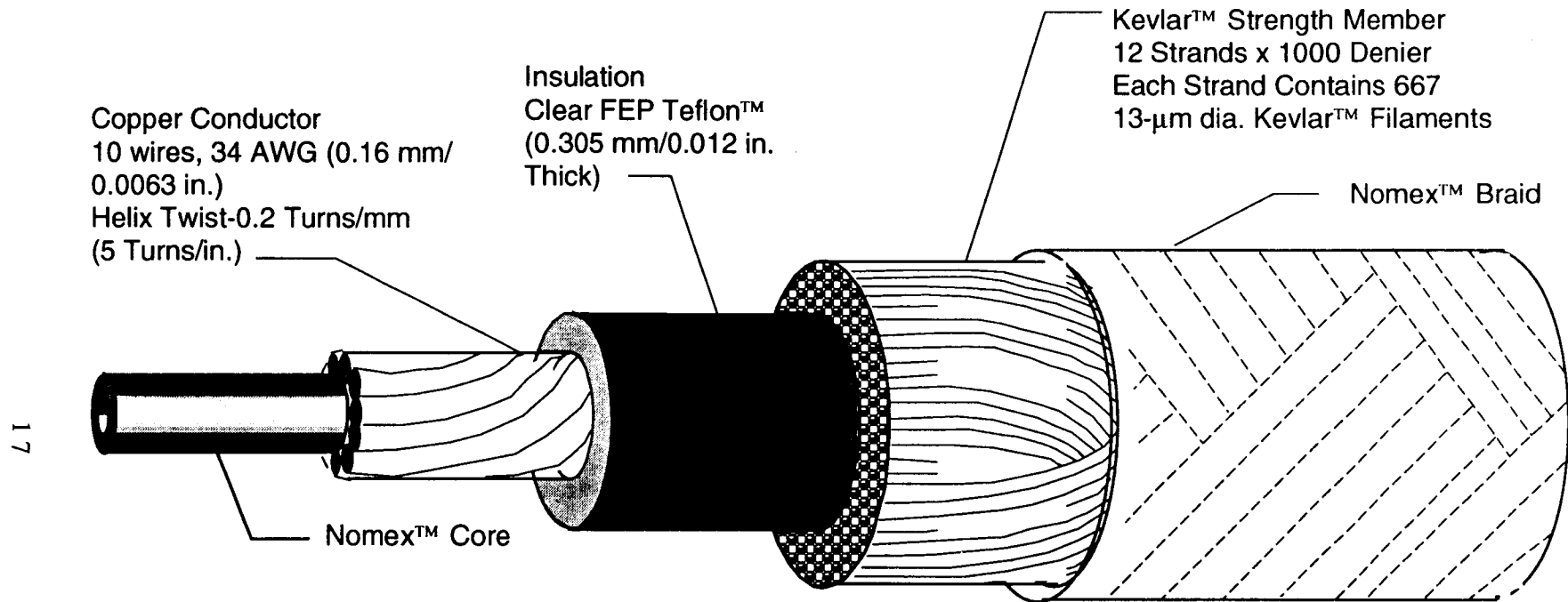


TSS predeploy configuration



Satellite/deployer interface

## TSS-1 Electrically Conductive Tether



<b>Diameter</b>	2.54 mm (0.1 in.)
<b>Max Mass</b>	8.2 kg/km (0.0055 lb/ft or 29.0 lb/mile)
<b>Breakstrength</b>	1780 N (400 lb)
<b>Temp Range</b>	-100°C to +125°C (-148°F to +257°F)
<b>Max Elongation</b>	5% at 1780 N
<b>Elec Breakdown Voltage</b>	10 kV (Specified), 15 kV (Qual)
<b>Elec Resistance</b>	0.12 $\Omega$ /m (Specified) 0.015 $\Omega$ /m (Actual at Room Temp)
<b>Leakage Current</b>	5 mA (Max) at 10 kVdc

The tether reel mechanism regulates the tether's length, tension and rate of deployment -- critical factors for tether control. Designed to hold up to 68 miles of tether, the reel is 3.3 feet in diameter and 3.9 feet long. The reel is equipped with a "level-wind" mechanism to assure uniform winding on the reel, a brake assembly for control of the tether and a drive motor. The mechanism is capable of letting out the tether at up to about 10 miles per hour. However, for the TSS-1 mission, the tether will be released at a much slower rate.

## **Tether**

The tether's length and electrical properties affect all aspects of tethered operations. For the TSS-1 mission, the tether will be reeled out to an altitude about 12 miles above the Shuttle, making the TSS-1/orbiter combination 100 times longer than any previous spacecraft. It will create a large current system in the ionosphere, similar to natural currents in the Earth's polar regions associated with the aurora borealis. When the tether's current is pulsed by electron accelerators, it becomes the longest and lowest frequency antenna ever placed in orbit. Also, for the first time, scientists can measure the level of charge or electric potential acquired by a spacecraft as a result of its motion through the Earth's magnetic field lines. All these capabilities are directly related to the structure of the bootlace-thick tether, a conducting cord designed to anchor a satellite miles above the orbiter.

The TSS-1 tether is 13.7 miles long. When deployed, it is expected to develop a 5,000-volt electrical potential and carry a maximum current of 1 ampere. At its center is the conductor, a 10-strand copper bundle wrapped around a Nomex (nylon fiber) core. The wire is insulated with a layer of Teflon, then strength is provided with a layer of braided Kevlar -- a tough, light synthetic fiber also used for making bulletproof vests. An outer braid of Nomex protects the tether from atomic oxygen. The cable is about 0.1 inch in diameter.

## **Satellite**

Developed by the Italian Space Agency, the spherical satellite is a little more than 5 feet in diameter and is latched atop the deployer's satellite support structure. The six latches are released when boom extension is initiated. After the satellite is extended some 40 feet above the orbiter atop the boom, tether unreeling will begin.

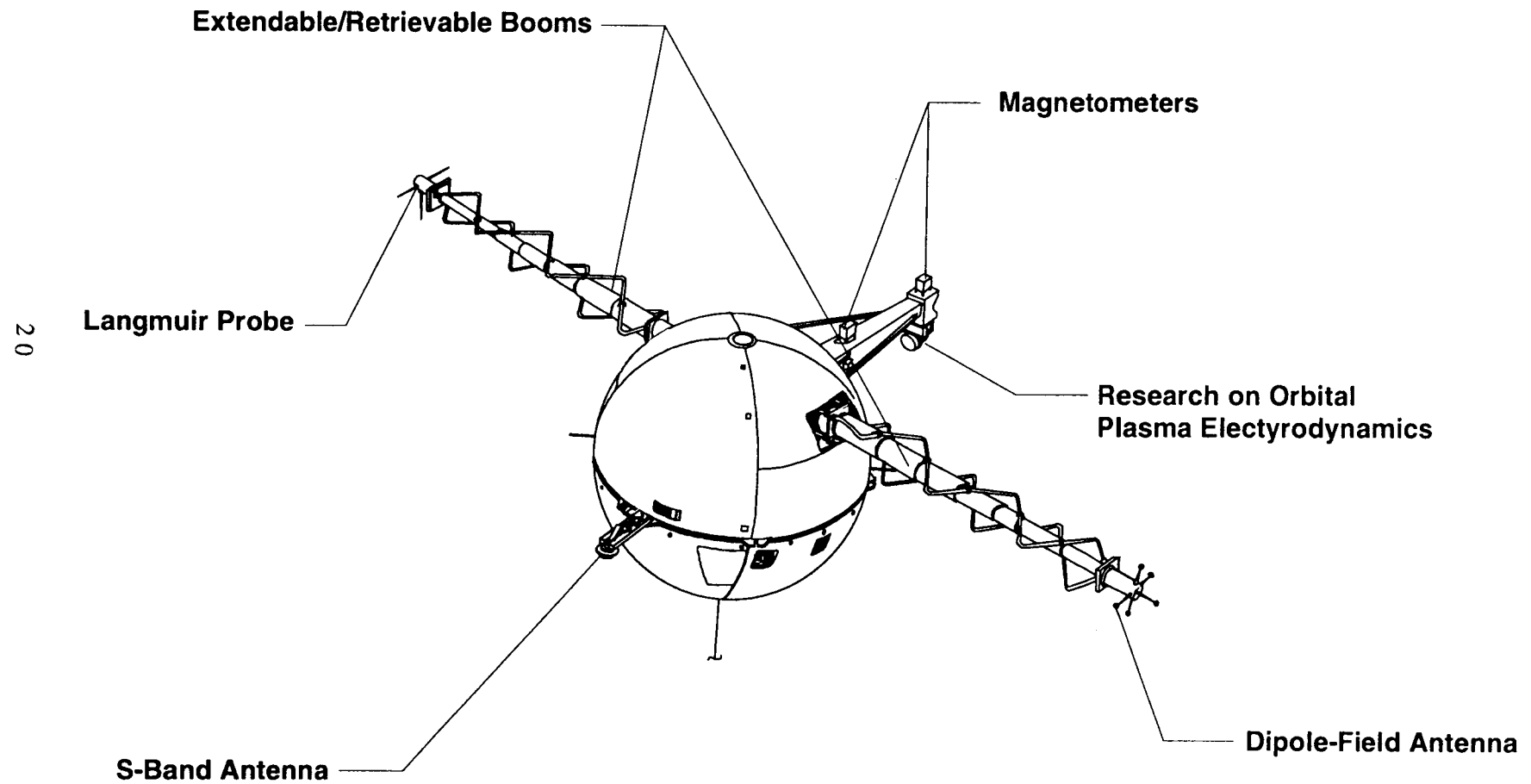
The satellite is divided into two hemispheres and a centered propulsion module. The payload module (the upper half of the sphere opposite the tether) houses satellite-based science instruments. Support systems for power distribution, data handling, telemetry and navigational equipment are housed in the service module or lower half. Eight aluminum-alloy panels, covered with electrically conductive paint, developed at the Marshall Space Flight Center, form the outer skin of the satellite. Doors in the panels provide access for servicing batteries; windows for sun, Earth and charged-particle sensors; and connectors for cables from the deployer.

A fixed boom for mounting science instruments extends some 39 inches from the equator of the satellite sphere. A short mast opposite the boom carries an S-band antenna for sending data and receiving commands. For the TSS-1 mission, the satellite is outfitted with two additional instrument-mounting booms on opposite sides of the upper sphere. The booms may be extended up to 8 feet from the body of the satellite, allowing instruments to sample the surrounding environment, then be retrieved inside the payload module before the satellite is reeled back to the Shuttle.

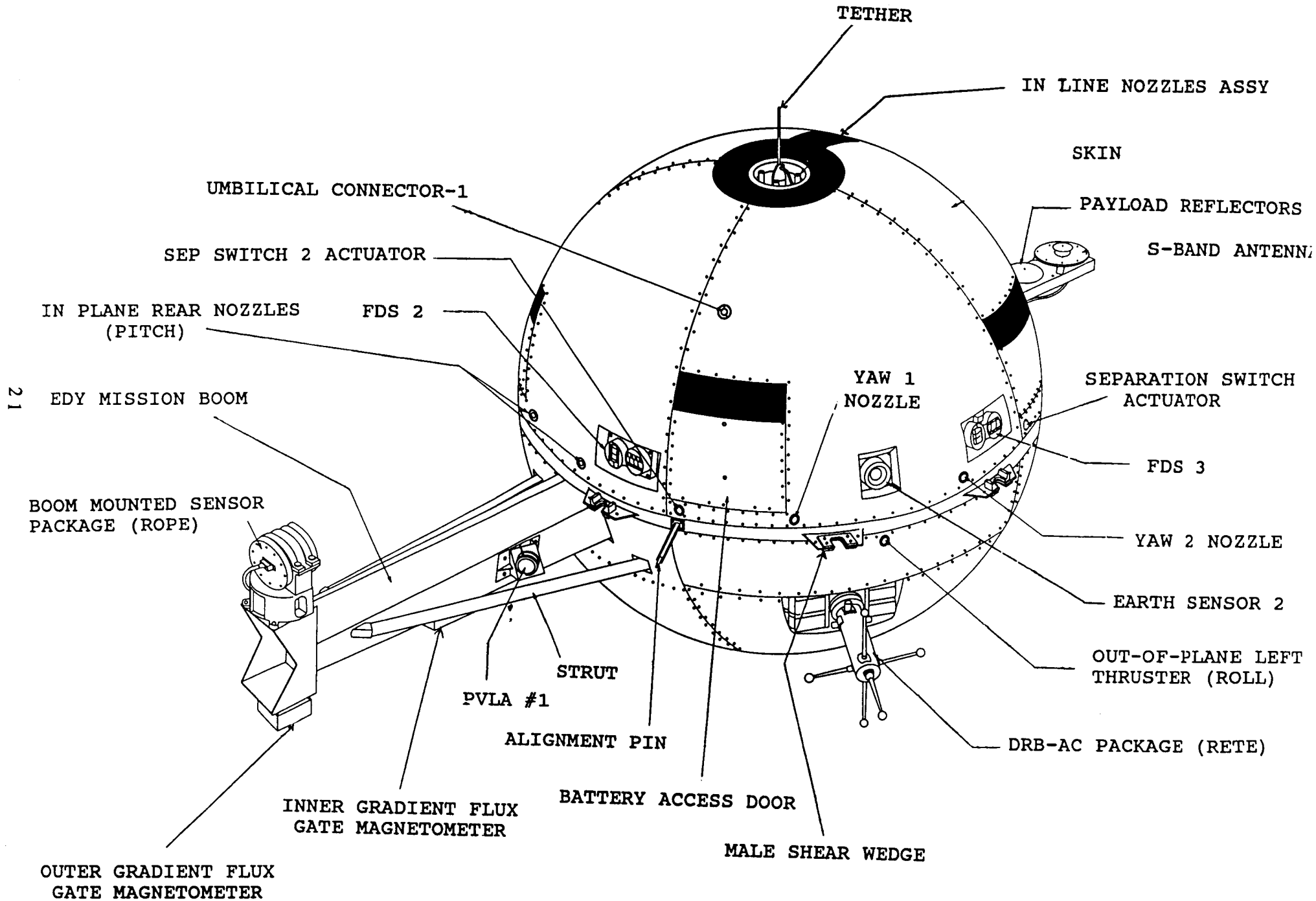
Attitude of the tethered satellite is controlled by its auxiliary propulsion module, while the satellite motion is controlled by the deployer's tether reel and motor. The module also initiates, maintains and controls satellite spin at up to 0.7 revolution per minute on command from the Shuttle. One set of thrusters near the tether attachment can provide extra tension on the tether, another can be used to reduce or eliminate pendulum-type motions in the satellite, and a third will be used to spin and de-spin the satellite. A pressurized tank containing gaseous nitrogen for the thrusters is located in the center of the sphere.

# TSS-1 Satellite

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# TSS



## **TETHERED SATELLITE SYSTEM-1 FLIGHT OPERATIONS**

The responsibility for flying the tethered satellite, controlling the stability of the satellite, tether and Atlantis, lies with the flight controllers in the Mission Control Center at the Johnson Space Center, Houston.

The primary flight control positions contributing to the flight of the Tethered Satellite System (TSS) are the Guidance and Procedures (GPO) area and the Payloads area. GPO officers will oversee the dynamic phases of deployment and retrieval of the satellite and are responsible for determining the correct course of action to manage any tether dynamics. To compute corrective actions, the GPO officers will combine data from their workstations with inputs from several investigative teams.

The Payloads area will oversee control of the satellite systems, the operation of the tether deployer and all other TSS systems. Payloads also serves as the liaison between Mission Control Center and the science investigators, sending all real-time commands for science operations to the satellite. Atlantis' crew will control the deployer reel and the satellite thrusters from onboard the spacecraft.

### **Deploy Operations**

The satellite will be deployed from Atlantis when the cargo bay is facing away from Earth, with the tail slanted upward and nose pitched down. A 39-foot long boom, with the satellite at its end, is raised out of the cargo bay to provide clearance between the satellite and Shuttle during deploy and retrieval operations. The orientation of the payload bay will result in the tethered satellite initially deployed upward but at an angle of about 40 degrees behind Atlantis' path.

Using the tether reel's electric motors to unwind the tether, an electric motor at the end of the boom to pull the tether off of the reel and a thruster on the satellite that pushes the satellite away from Atlantis, the satellite will be moved away from the Shuttle. The deployment will begin extremely slowly, with the satellite, after 1 hour has elapsed since the tether was first unwound, moving away from Atlantis at about one-half mile per hour. The initial movement of the satellite away from the boom will be at less than two-hundredths of 1 mile per hour. The speed of deploy will continue to increase, peaking after 1 and a half hours from the initial movement to almost 4 miles per hour.

At this point, when the satellite is slightly less than 1 mile from Atlantis, the rate of deployment will begin slowing briefly, a maneuver that is planned to reduce the 40-degree angle to 5 degrees and put the satellite in the same plane almost directly overhead of Atlantis by the time that about 3 miles of tether has been unwound.

When the satellite is 3.7 miles from Atlantis, 2 and one-half hours after the start of deployment, a one-quarter of a revolution-per-minute spin will be imparted to it via its attitude control system thrusters. The slight spin is needed for science operations with the satellite.

After this, the speed of deployment will again be increased gradually, climbing to a peak separation from Atlantis of almost 5 mph about 4 hours into the deployment when the satellite is about 9 miles distant. From this point, the speed with which the tether is fed out will gradually decrease through the rest of the procedure, coming to a stop almost 5 and half hours after the initial movement, when the satellite is almost 12.5 miles from Atlantis. Just prior to the satellite arriving on station at 12.5 miles distant, the quarter-revolution spin will be stopped briefly to measure tether dynamics and then, a seven-tenths of a revolution-per-minute spin will be imparted to it. At full deploy, the tension on the tether or the pull from the satellite is predicted to be equivalent to about 10 pounds of force.

The tether, in total, is 13.7 miles long, allowing an extra 1.2 miles of spare tether that is not planned to be unwound during the mission.

### **Dynamics Functional Objectives**

During the deploy of TSS, several tests will be conducted to explore control and dynamics of a tethered satellite. Models of deployment have shown that the longer the tether becomes, the more stable the system becomes. The dynamics and control tests to be conducted during deploy also will aid in preparing for retrieval of the satellite and serve to verify the ability to control the satellite during that operation. During retrieval, it is expected that the stability of the system will decrease as the tether is shortened, just opposite the way stability increased as the tether was lengthened during deploy.

The dynamics tests involve maintaining a constant tension on the tether and correcting any of several possible disturbances to it. Possible disturbances include: a bobbing motion, also called a plumb bob, where the satellite bounces slightly on the tether causing it to alternately slacken and tighten; a vibration of the tether, called a libration, resulting in a clock-pendulum type movement of tether and satellite; a pendulous motion of the satellite or a rolling and pitching action by the satellite at the end of the tether; and a lateral string mode disturbance, a motion where the satellite and Shuttle are stable, but the tether is moving back and forth in a "skip rope" motion. All of these disturbances may occur naturally and are not unexpected.

The first test objectives will be performed before the satellite reaches 200 yards from Atlantis and will involve small firings of Atlantis' steering jets to test the disturbances these may impart to the tether and satellite. The crew will test three different methods of damping the libration (clock pendulum) motion expected to be created in the tether and the pendulous (rolling and pitching) motion expected in the satellite. First, using visual contact with the satellite, to manually stabilize it from onboard the Shuttle by remotely firing TSS's attitude thrusters. Second, using the telemetry information from the satellite to manually fire the satellite's attitude thrusters. Third, using an automatic attitude control system for the satellite via the Shuttle's flight control computers to automatically fire the TSS thrusters and stabilize the system.

Another test will be performed when the satellite is about 2.5 miles from Atlantis. Atlantis' autopilot will be adjusted to allow the Shuttle to wobble by as much as 10 degrees in any direction before steering jets automatically fire to maintain Atlantis' orientation. The 10-degree deadband will be used to judge any disturbances that may be imparted to the satellite if a looser attitude control is maintained by Atlantis. The standard deadband, or degree of wobble, set in Shuttle autopilot for the tethered satellite operations is 2 degrees of wobble. Tests using the wider deadband will allow the crew and flight controllers to measure the amount of motion the satellite and tether impart to Atlantis.

Dampening of the various motions expected to occur in the tether and satellite will be accomplished while at 12.5 miles using electrical current flow through the tether. During retrieval, test objectives will be met using a combination of the Shuttle's steering jets, a built-in dampening system at the end of the deploy boom and the satellite's steering jets.

### **Tether Retrieval Operations**

Tether retrieval will occur more slowly than deployment. The rate of tether retrieval, the closing rate between Atlantis and the satellite, will build after 5 hours since first movement to a peak rate of about 3 miles per hour. At that point, when the satellite is about 4 and a half miles from Atlantis, the rate of retrieval will gradually decrease, coming to a halt 10 hours after start of retrieval operations when the satellite is 1.5 miles from Atlantis.

The satellite will remain at 1.5 miles from Atlantis for about 5 hours of science operations before the final retrieval begins. Final retrieval is expected to take about 2 hours. A peak rate of closing between Atlantis and the satellite of about 1.5 miles per hour will be attained just after the final retrieval begins, and the closing rate will decrease gradually through the remainder of the operation. The closing rate at the time the satellite is docked to the cradle at the end of the deployer boom is planned to be less than one-tenth of 1 mile per hour.

If the safety of the orbiter becomes a concern, the tether will be cut and the satellite released or the satellite and boom jettisoned.

## **TSS-1 SCIENCE OPERATIONS**

Speeding through the magnetized ionospheric plasma at almost 5 miles per second, a 12-mile-long conducting tethered system should create a variety of very interesting plasma-electrodynamic phenomena. These are expected to provide unique experimental capabilities, including the ability to collect an electrical charge and drive a large current system within the ionosphere; generate high voltages (on the order of 5 kilovolts) across the tether at full deployment; control the satellite's electrical potential and its plasma sheath (the layer of charged particles created around the satellite); and generate low-frequency electrostatic and electromagnetic waves. It is believed that these capabilities can be used to conduct controlled experimental studies of phenomena and processes that occur naturally in plasmas throughout the solar system, including Earth's magnetosphere.

A necessary first step toward these studies -- and the primary science goal of the TSS-1 mission -- is to characterize the electrodynamic behavior of the satellite-tether-orbiter system. Of particular interest is the interaction of the system with the charged particles and electric and magnetic fields in the ionosphere.

A circuit must be closed to produce an electrical current. For example, in a simple circuit involving a battery and a light bulb, current travels down one wire from the battery to the bulb, through the bulb and back to the battery via another wire completing the circuit. Only when the circuit is complete will the bulb illuminate. The conductive outer skin of the satellite collects free electrons from the space plasma, and the induced voltage causes the electrons to flow down the conductive tether to the Shuttle. Then, they will be ejected back into space by electron generators (Core equipment).

Scientists expect the electrons to travel along magnetic field lines in the ionosphere to complete the loop. TSS-1 investigators will use a series of interdependent experiments conducted with the electron guns and tether current-control hardware, along with a set of diagnostic instruments, to assess the nature of the external current loop within the ionosphere and the processes by which current closure occurs at the satellite and the orbiter.

### **Science Operations**

The TSS-1 mission is comprised of 11 scientific investigations selected jointly by NASA and the Italian Space Agency. In addition, the U.S. Air Force's Phillips Laboratory, by agreement, is providing an experimental investigation. Seven investigations provide equipment that either stimulates or monitors the tether system and its environment. Two investigations will use ground-based instruments to measure electromagnetic emissions from the Tethered Satellite System as it passes overhead, and three investigations were selected to provide theoretical support in the areas of dynamics and electrodynamics.

Most of the TSS-1 experiments require measurements of essentially the same set of physical parameters, with instrumentation from each

investigation providing different parts of the total set. While some instruments measure magnetic fields, others record particle energies and densities, and still others map electric fields. A complete set of data on plasma and field conditions is required to provide an accurate understanding of the space environment and its interaction with the tether system. TSS-1 science investigations, therefore, are interdependent. They must share information and operations to achieve their objectives. In fact, these investigations may be considered to be different parts of a single complex experiment.

The TSS-1 principal and associate investigators and their support teams will be located in a special Science Operations Center at the Mission Control Center in Houston. During the tethered satellite portion of the STS-46 flight, all 12 team leaders will be positioned at a conference table in the operations center. Science data will be available to the entire group, giving them an integrated "picture" of conditions observed by all the instruments. Together, they will assess performance of the experiment objectives. Commands to change any instrument mode that affects the overall data set must be approved by the group, because such a change could impact the overall science return from the mission. Requests for adjustments will be relayed by the mission scientist, the group's leader, to the science operations director for implementation.

The primary scientific data will be taken during the approximately 10.5-hour phase (called "on-station 1") when the satellite is extended to the maximum distance above the Shuttle. Secondary science measurements will be taken prior to and during deployment, during "on-station 1," and as the satellite is reeled back to the orbiter. However, after accomplishment of the primary science objectives, tether dynamic control takes priority over further science data gathering.

Science activities during the TSS-1 mission will be directed by the science principal investigator team and implemented by a payload cadre made up primarily of Marshall Space Flight Center employees and their contractors. Science support teams for each of the 12 experiments will monitor the science hardware status. From the Science Operations Center at Mission Control, the principal investigator team will be able to evaluate the quality of data obtained, replan science activities as needed and direct adjustments to the instruments. The cadre will be led by a science operations director, who will work closely with the mission scientist, the mission manager and Mission Control's payloads officer to coordinate science activities.

During the mission, most activities not carried out by the crew will be controlled by command sequences, or timeline files, written prior to the mission and stored in an onboard computer. For maximum flexibility, however, during all TSS phases, modifications to these timeline files may be uplinked, or commands may be sent in real-time from the Science Operations Center to the on-board instruments.

## **SCIENCE INVESTIGATIONS**

### **TSS Deployer Core Equipment and Satellite Core Equipment (DCORE/SCORE)**

Principal Investigator:

Dr. Carlo Bonifazi  
Italian Space Agency, Rome, Italy

The Tethered Satellite System Core Equipment controls the electrical current flowing between the satellite and the orbiter. It also makes a number of basic electrical and physical measurements of the system.

Mounted on the aft support structure in the Shuttle cargo bay, the Deployer Core Equipment features two identical electron generators (the prime and the back up) that can each eject up to 750 milli-amperes ( $3/4$  amp) of current from the system. A master switch, the electron generator control switches, power distribution and electronic control unit, and command and data interfaces also are included in the deployer core package. A voltmeter measures tether potential with respect to the orbiter structure, and a vacuum gauge measures ambient gas pressure to prevent operations if pressure conditions might cause electrical arcing.

Core equipment located on the satellite itself includes an ammeter to measure tether current collected on the skin of the TSS-1 satellite and an accelerometer-gyro three axes packages to measure satellite motion and attitude.

### **Research on Orbital Plasma Electrodynamics (ROPE)**

Principal Investigator:

Dr. Nobie Stone  
NASA Marshall Space Flight Center, Huntsville, Ala.

This experiment studies behavior of ambient charged particles in the ionosphere and ionized neutral particles around the satellite under a variety of conditions. Comparisons of readings from its instruments should allow scientists to determine where the particles come from that make up the tether current as well as the distribution and flow of charged particles in the space immediately surrounding the satellite.

The Differential Ion Flux Probe, mounted on the end of the satellite's fixed boom, measures the energy, temperature, density and direction of ambient ions that flow around the satellite as well as neutral particles that have been ionized in its plasma sheath and accelerated outward by the sheath's electric field.

The Soft Particle Energy Spectrometer is actually five electrostatic analyzers -- three mounted at different locations on the surface of the satellite itself, and the other two mounted with the Differential Ion Flux

Probe on the boom. Taken together, measurements from the two boom-mounted sensors can be used to determine the electrical potential of the sheath of ionized plasma surrounding the satellite. The three satellite-mounted sensors will measure geometric distribution of the current to the satellite's surface.

### **Research on Electrodynamic Tether Effects (RETE)**

Principal Investigator:

Dr. Marino Dobrowolny  
Italian National Research Council, Rome, Italy

This experiment measures the electrical potential in the plasma sheath around the satellite and identifies waves excited by the satellite and tether system. The instruments are located in two canisters at the end of the satellite's extendible booms. As the satellite spins, the booms are extended, and the sensors sweep the plasma around the entire circumference of the spacecraft. To produce a profile of the plasma sheath, measurements of direct-current potential and electron currents are made both while the boom is fully extended and as it is being extended or retracted. The same measurements, taken at a fixed distance from the spinning satellite, produce a map of the angular structure of the sheath.

### **Magnetic Field Experiment for TSS Missions (TEMAG)**

Principal Investigator:

Prof. Franco Mariani  
Second University of Rome, Italy

The primary goal of this investigation is to map the levels and fluctuations in magnetic fields around the satellite. Two magnetometers -- very accurate devices for measuring such fields -- are located on the fixed boom of the satellite, one at its end and the other at its midpoint. Comparing measurements from the two magnetometers allows real-time estimates to be made of unwanted disturbances to the magnetic fields produced by the presence of satellite batteries, power systems, gyros, motors, relays and other magnetic material. After the mission, the variable effects of switching satellite subsystems on and off, of thruster firings and of other operations that introduce magnetic disturbances will be modeled on the ground, so these satellite effects can be subtracted from measurements of the ambient magnetic fields in space.

## **Shuttle Electrodynamic Tether System (SETS)**

Principal Investigator:

Dr. Peter Banks  
University of Michigan, Ann Arbor

This investigation studies the ability of the tethered satellite to collect electrons by determining current and voltage of the tethered system and measuring the resistance to current flow in the tether itself. It also explores how tether current can be controlled by the emission of electrons at the orbiter end of the system and characterizes the charge the orbiter acquires as the tether system produces power, broadcasts low-frequency radio waves and creates instabilities in the surrounding plasma.

The hardware is located on the support structure in the orbiter cargo bay. In addition to three instruments to characterize the orbiter's charge, the experiment includes a fast-pulse electron accelerator used to help neutralize the orbiter's charge. It is located close to the core electron gun and aligned so beams from both are parallel. The fast-pulse accelerator acts as a current modulator, emitting electron beams in recognizable patterns to stimulate wave activity over a wide range of frequencies. The beams can be pulsed with on/off times on the order of 100 nanoseconds.

## **Shuttle Potential and Return Electron Experiment (SPREE)**

Associate Investigators:

Dr. Dave Hardy and Capt. Marilyn Oberhardt  
Dept. of the Air Force, Phillips Laboratory, Bedford, Mass.

Also located on the support structure, this experiment will measure populations of charged particles around the orbiter. Measurements will be made prior to deployment to assess ambient space conditions as well as during active TSS-1 operations. The measurements will determine the level of orbiter charging with respect to the ambient space plasma, characterize the particles returning to the orbiter as a result of TSS-1 electron beam ejections and investigate local wave-particle interactions produced by TSS-1 operations. Such information is important in determining how the Tethered Satellite System current is generated, and how it is affected by return currents to the orbiter. The experiment uses two sets of two nested electrostatic analyzers each, which rotate at approximately 1 revolution per minute, sampling the electrons and ions in and around the Shuttle's cargo bay.

## **THE TSS-1 TEAM**

Within NASA, the Tethered Satellite System program is directed by the Office of Space Flight and the Office of Space Science and Applications. The Space Systems Projects Office at the Marshall Space Flight Center, Huntsville, Ala., has responsibility for project management and overall systems engineering. Experiment hardware systems were designed and developed by the U.S. and Italy. Responsibility for integration of all hardware, including experiment systems on the MPES pallet, is assigned to the project manager at the Marshall center. The Kennedy Space Center, Florida, is responsible

for launch-processing and launch of the TSS-1 payload. The Johnson Space Center, Houston, has responsibility for TSS-1/STS integration and mission operations.

R.J. Howard of the Office of Space Science and Applications, NASA Headquarters, Washington, D.C., is the TSS-1 Science Payload Program Manager. The TSS Program Manager is Tom Stuart of the Office of Space Flight, NASA Headquarters. Billy Nunley is NASA Project Manager and TSS-1 Mission Manager at the Marshall Space Flight Center. Dr. Nobie Stone, also of Marshall, is the NASA TSS-1 Mission Scientist, the TSS Project Scientist and Co-chairman of the Investigator Working Group.

For the Italian Space Agency responsible for the satellite, Core equipment and Italian experiments development and for the science integration into the satellite, Dr. Gianfranco Manarini is Program Manager for TSS-1, while the Program Scientist is Dr. F. Mariani. Dr. Marino Dobrowolny is the Project Scientist for the Italian Space Agency, and Co-chairman of the investigator group. Dr. Maurizio Candidi is the Mission Scientist for the Italian Space Agency.

Martin Marietta, Denver, Colo., developed the tether and control system deployer for NASA. Alenia Spazio in Turin, Italy, developed the satellite and the Core equipment for the Italian Space Agency.

## TSS-1 SCIENCE INVESTIGATIONS

<b>Title</b>	<b>Institution (Nation)</b>
Research on Electrodynamic Tether Effects	CNR or Italian National Research Council (Italy)
Research on Orbital Plasma Electrodynamics	NASA/MSFC (U.S.)
Shuttle Electrodynamic Tether Sys.	University of Michigan (U.S.)
Magnetic Field Experiments for TSS Missions	Second University of Rome (Italy)
Theoretical & Experimental Investigation of TSS Dynamics	Univ. of Padua (Italy)
Theory & Modeling in Support of Tethered Satellite	SAIC (U.S.)
Investigation of Electromagnetic Emissions for Electrodynamic Tether	Smithsonian Astrophysical Observatory (U.S.)
Investigation and Measurement of Dynamic Noise in TSS	Smithsonian Astrophysical Observatory (U.S.)
Observation on Earth's Surface of Electromagnetic Emissions by TSS	Univ. of Genoa (Italy)
Deployer Core Equipment and Satellite Core Equipment	ASI (Italy)
Tether Optical Phenomena Experiment	Lockheed (U.S.)
Shuttle Potential & Return Electron Experiment	Dept. of the Air Force Phillips Laboratory (U.S.)

## **EUROPEAN RETRIEVABLE CARRIER (EURECA)**

The European Space Agency's (ESA) EURECA will be launched by the Space Shuttle and deployed at an altitude of 425 km. It will ascend, using its own propulsion, to its operational orbit of 515 km. After 6 to 9 months in orbit, it will descend to the lower orbit where it will be retrieved by another orbiter and brought back to Earth. It will be refurbished and equipped for the next mission.

The first mission (EURECA-1) primarily will be devoted to research in the fields of material and life sciences and radiobiology, all of which require a controlled microgravity environment. The selected microgravity experiments will be carried out in seven facilities. The remaining payload comprises space science and technology.

During the first mission, EURECA's residual carrier accelerations will not exceed 10<sup>-5</sup>g. The platform's altitude and orbit control system makes use of magnetic torquers augmented by cold gas thrusters to keep disturbance levels below 0.3 Nm during the operational phase.

### **Physical characteristics**

- o Launch mass.....4491 kg
- o Electrical power solar array.....5000w
- o Continuous power to EURECA experiments.....1000w
- o Launch configuration.....dia: 4.5m, length: 2.54m
- o Volume.....40.3m
- o Solar array extended.....20m x 3.5

### **User friendly**

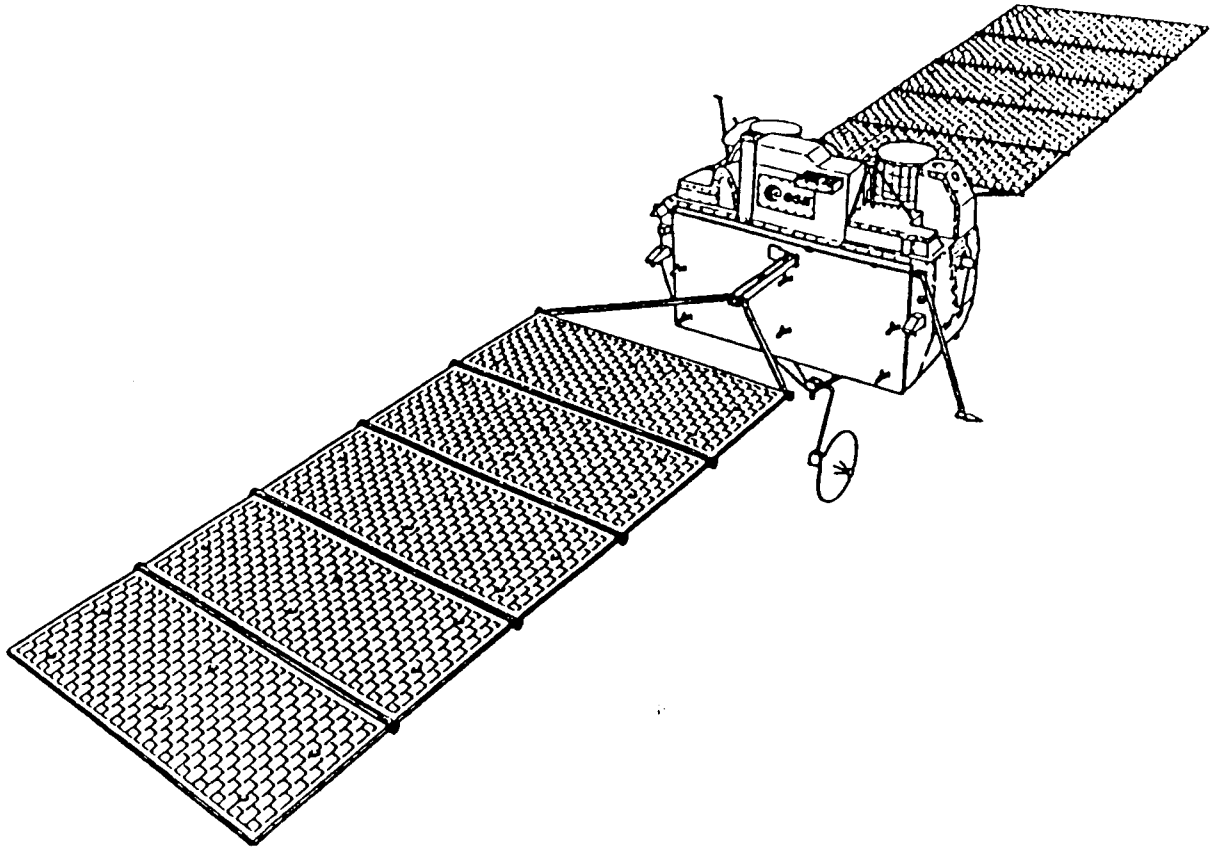
Considerable efforts have been made during the design and development phases to ensure that EURECA is a "user friendly" system. As is the case for Spacelab, EURECA has standardized structural attachments, power and data interfaces. Unlike Spacelab, however, EURECA has a decentralized payload control concept. Most of the onboard facilities have their own data handling device so that investigators can control the internal operations of their equipment directly. This approach provides more flexibility as well as economical advantages.

### **Operations**

EURECA is directly attached to the Shuttle cargo bay by means of a three-point latching system. The spacecraft has been designed with a minimum length and a close-to-optimum length-to-mass ratio, thus helping to keep down launch and retrieval costs.

All EURECA operations will be controlled by ESA's Space Operations Centre (ESOC) in Darmstadt, Germany. During the deployment and retrieval operations, ESOC will function as a Remote Payload Operations Control

# EURECA -1L



The EURECA spacecraft configuration

Centre to NASA's Mission Control Center, Houston, and the orbiter will be used as a relay station for all the commands. In case of unexpected communication gaps during this period, the orbiter crew has a back-up command capability for essential functions.

Throughout the operational phase, ESOC will control EURECA through two ground stations at Maspalomas, ---, and Kourou, French Guiana. EURECA will be in contact with its ground stations for a relatively short period each day. When it is out of contact, or "invisible", its systems operate with a high degree of autonomy, performing failure detection, isolation and recovery activities to safeguard ongoing experimental processes.

An experimental advanced data relay system, the Inter-orbit Communication package, is included in the first payload. This package will communicate with the European Olympus Communication Satellite to demonstrate the possible improvements for future communications with data relay satellites. As such a system will significantly enhance realtime data coverage, it is planned for use on subsequent EURECA missions to provide an operational service via future European data relay satellites.

## **EURECA Retrievable Carrier**

### **Structure**

The EURECA structure is made of high strength carbon-fibre struts and titanium nadal points joined together to form a framework of cubic elements. This provides relatively low thermal distortions, allows high alignment accuracy and simple analytical verification, and is easy to assemble and maintain. Larger assemblies are attached to the nadal points. Instruments weighing less than 100 kg are assembled on standard equipment support panels similar to those on a Spacelab pallet.

### **Thermal Control**

Thermal control for EURECA combines active and passive heat transfer and radiation systems. Active transfer, required for payload facilities which generated more heat, is achieve by means of a freon cooling loop which dissipates the thermal load through two radiators into space. The passive system makes use of multilayer insulation blankets combined with electrical heaters. During nominal operations, the thermal control subsystem rejects a maximum heat load of about 2300 w.

### **Electrical Power**

The electrical power subsystem generates, stores, conditions and distributes power to all the spacecraft subsystems and to the payload. The deployable and retracable solar arrays, with a combined raw power output of some 5000 w together with four 40 amp-hour (Ah) nickel-cadmium batteries, provide the payload with a continuous power of 1000 w, nominally at 28 volts, with peak power capabilities of up to 1500 w for several minutes. While EURECA is in the cargo bay, electric power is provided by the Shuttle

to ensure that mission critical equipment is maintained within its temperature limits.

### **Attitude and Orbit Control**

A modular attitude and orbit control subsystem (AOCS) is used for attitude determination and spacecraft orientation and stabilization during all flight operations and orbit control manoeuvres. The AOCS has been designed for maximum autonomy. It will ensure that all mission requirements are met even in case of severe on-board failures, including non-availability of the on-board data handling subsystem for up to 48 hours.

An orbit transfer assembly, consisting of two redundant sets of four thrusters, is used to boost EURECA to its operation attitude at 515 km and to return it to its retrieval orbit at about 300 km. The amount of onboard propellant hydrazine is sufficient for the spacecraft to fly different mission profiles depending on its nominal mission duration which may be anywhere between 6 and 9 months.

EURECA is three-axis stabilized by means of a magnetic torque assembly together with a nitrogen reaction control assembly (RCA). This specific combination of actuators was selected because its' control accelerations are well below the microgravity constraints of the spacecraft. The RCA cold gas system can be used during deployment and retrieval operations without creating any hazards for the Shuttle.

### **Communications and Data Handling**

EURECA remote control and autonomous operations are carried out by means of the data handling subsystem (DHS) supported by the telemetry and telecommand subsystems which provide the link to and from the ground segment. Through the DHS, instructions are stored and executed, telemetry data is stored and transmitted, and the spacecraft and its payload are controlled when EURECA is no longer "visible" from the ground station.

**Solution Growth Facility (SGF)**

Principal Investigator:

J.C. Legros  
Université Libre de Bruxelles, Brussels, Belgium

The Solution Growth Facility (SGF) is a multi-user facility dedicated to the growth of monocrystals from solution, consisting of a set of four reactors and their associated control system.

Three of the reactors will be used for the solution growth of crystals. These reactors have a central buffer chamber containing solvent and two reservoirs containing reactant solutions. The reservoirs are connected to the buffer chamber by valves which allow the solutions to diffuse into the solvent and hence, to crystallize.

The fourth reactor is divided into twenty individual sample tubes which contain different samples of binary organic mixtures and aqueous electrolyte solutions. This reactor is devoted to the measurement of the Soret coefficient, that is, the ratio of thermal to isothermal diffusion coefficient.

The SGF has been developed under ESA contract by Laben and their subcontractors Contraves and Terma.

**Protein Crystallization Facility (PCF)**

Principal Investigator:

W. Littke  
Chemisches Laboratorium, Universität Freiburg, Freiburg, Germany

The Protein Crystallization Facility (PCF) is a multi-user solution growth facility for protein crystallization in space. The object of the experiments is the growth of single, defect-free protein crystals of high purity and of a size sufficient to determine their molecular structure by x-ray diffraction. This typically requires crystal sizes in the order of a few tenths of a millimeter.

The PCF contains twelve reactor vessels, one for each experiment. Each reactor, which is provided with an individually controlled temperature environment, has four chambers -- one containing the protein, one containing a buffer solution and two filled with salt solutions. When the reactors have reached their operating temperatures, one of the salt solution chambers, the protein chamber and the buffer solution chamber are opened. Salt molecules diffuse into the buffer chamber causing the protein solution to crystallize. At the end of the mission the second salt solution chamber is activated to increase the salt concentration. This stabilizes the crystals and prevents them from dissolving when individual temperature control for the experiments ceases and the reactors are maintained at a common storage temperature.

One particular feature of the PCF is that the crystallization process can be observed from the ground by means of a video system.

The PCF has been developed under ESA contract by MBB Deutsche Aerospace and their subcontractors Officine Galileo and Reusser.

### **Exobiology And Radiation Assembly (ERA)**

Principal Investigator:

H. Bückner

Institut für Flugmedizin Abteilung Biophysik, German Aerospace Research Establishment (DLR), Cologne, Germany

The Exobiology and Radiation Assembly (ERA) is a multi-user life science facility for experiments on the biological effects of space radiation. Our knowledge of the interaction of cosmic ray particles with biological matter, the synergism of space vacuum and solar UV, and the spectral effectiveness of solar UV on viability should be improved as a result of experiments carried out in the ERA.

The ERA consists of deployable and fixed experiment trays and a number of cylindrical stacks, known as Biostacks, containing biological objects such as spores, seeds or eggs alternated with radiation and track detectors. An electronic service module also is included in the facility. The deployable trays carry biological specimens which are exposed to the different components of the space radiation environment for predetermined periods of time. The duration of exposure is controlled by means of shutters and the type of radiation is selected by the use of optical bandpass filters.

The ERA has been developed under ESA contract by Sira Ltd..

### **Multi-Furnace Assembly (MFA)**

Principal Investigator:

A. Passerone

Ist. di Chimica Fisica Applicata dei Materiali, National Research Council (CNR), Genova, Italy

The Multi-Furnace Assembly (MFA) is a multi-user facility dedicated to material science experiments. It is a modular facility with a set of common system interfaces which incorporates twelve furnaces of three different types, giving temperatures of up to 1400°C. Some of the furnaces are provided by the investigators on the basis of design recommendations made by ESA. The remainder are derived from furnaces flown on other missions, including some from sounding rocket flights. These are being used on EURECA after the necessary modifications and additional qualification. The experiments are performed sequentially with only one furnace operating at any one time.

The MFA has been developed under ESA contract by Deutsche Aerospace, ERNO Raumfahrttechnik and their subcontractors SAAB, Aeritalia, INTA and Bell Telephone.

### **Automatic Mirror Furnace (AMF)**

Principal Investigator:

K.W. Benz  
Kristallographisches Institut, Universität Freiburg, Freiburg, Germany

The Automatic Mirror Furnace (AMF) is an optical radiation furnace designed for the growth of single, uniform crystals from the liquid or vapor phases, using the traveling heater or Bridgman methods.

The principal component of the furnace is an ellipsoidal mirror. The experimental material is placed at the lower ring focus of the mirror and heated by radiation from a 300 w halogen lamp positioned at the upper focus. Temperatures of up to 1200°C can be achieved, depending on the requirements of individual samples. Seven lamps are available and up to 23 samples can be processed in the furnace.

As the crystal grows, the sample holder is withdrawn from the mirror assembly at crystallization speed, typically 2 mm/day, to keep the growth site aligned with the furnace focus. The sample also is rotated while in the furnace.

The AMF is the first of a new generation of crystal growth facilities equipped with sample and lamp exchange mechanisms. Fully automatic operations can be conducted in space during long microgravity missions on free flying carriers. During a 6 month mission, about 20 different crystal growth experiments can be performed.

The AMF has been developed under ESA contract by Dornier Deutsche Aerospace and their subcontractors Laben, ORS and SEP.

### **Surface Forces Adhesion Instrument (SFA)**

Principal Investigator:

G. Poletti  
Universita di Milano, Milan, Italy

The Surface Forces Adhesion instrument (SFA) has been designed to study the dependence of surface forces and interface energies on physical and chemical-physical parameters such as surface topography, surface cleanliness, temperature and the deformation properties of the contacting bodies. The SFA experiment aims at refining current understanding of adhesion-related phenomena, such as friction and wear, cold welding techniques in a microgravity environment and solid body positioning by means of adhesion.

Very high vacuum dynamic measurements must be performed in microgravity conditions because of the extreme difficulty experienced on Earth in controlling the physical parameters involved. As a typical example, the interface energy of a metallic sphere of 1 g mass contacting a plane target would be of the order of  $10^{-3}$  erg, corresponding to a potential gravitational energy related to a displacement of  $10^{-5}$  mm. In the same experiment performed on the EURECA platform, in a 10 to 100,000 times lower gravity environment, this energy corresponds to a displacement of 1 mm, thus considerably improving measurements and reducing error margins.

The SFA instrument has been funded by the Scientific Committee of the Italian Space Agency (ASI) and developed by the University of Milan and their subcontractors Centrotecnica, Control Systems and Rial.

### **High Precision Thermostat Instrument (HPT)**

Principal Investigator:

G. Findenegg  
Ruhr Universität Bochum, Bochum, Germany

Basic physics phenomena around the critical point of fluids are not, as yet, fully understood. Measurements in a microgravity environment, made during the German mission D-1, seem to be at variance with the expected results. Further investigations of critical phenomena under microgravity conditions are of very high scientific value.

The High Precision Thermostat (HPT) is an instrument designed for long term experiments requiring microgravity conditions and high precision temperature measurement and control. Typical experiments are "caloric", "critical point" or "phase transition" experiments, such as the "Adsorption" experiment designed for the EURECA mission.

This experiment will study the adsorption of Sulphur Hexafluoride ( $\text{SF}_6$ ), close to its critical point ( $T_c=45.55^\circ\text{C}$ ,  $p_c=0.737 \text{ g/cm}^3$ ) on graphitised carbon. A new volumetric technique will be used for the measurements of the adsorption coefficient at various temperatures along the critical isochore starting from the reference temperature in the one-phase region ( $60^\circ\text{C}$ ) and approaching the critical temperature. The results will be compared with 1g measurements and theoretical predictions.

The HPT has been developed under DLR contract by Deutsche Aerospace, ERNO Raumfahrttechnik and their subcontractor Kayser-Threde GmbH.

## **Solar Constant And Variability Instrument (SOVA)**

Principal Investigator:

D. Crommelynck

Institut Royal Météorologique de Belgique (IRMB), Brussels, Belgium

The Solar Constant and Variability Instrument (SOVA) is designed to investigate the solar constant, its variability and its spectral distribution, and measure:

- o fluctuations of the total and spectral solar irradiance within periods of a few minutes up to several hours and with a resolution of  $10^{-6}$  to determine the pressure and gravity modes of the solar oscillations which carry information on the internal structure of the sun;

- o short term variations of the total and spectral solar irradiance within time scales ranging from hours to few months and with a resolution of  $10^{-5}$  for the study of energy redistribution in the solar convection zone. These variations appear to be associated with solar activities (sun spots);

- o long term variations of the solar luminosity in the time scale of years (solar cycles) by measuring the absolute solar irradiance with an accuracy of better than 0.1 percent and by comparing it with previous and future measurements on board Spacelab and other space vehicles. This is of importance for the understanding of solar cycles and is a basic reference for climatic research.

The SOVA instrument has been developed by the IRMB, by the Physikalisch-Meteorologisch-ches Observatorium World Radiation Center (PMOD/WRC) Davos, Switzerland, and by the Space Science Department (SSD) of the European Space Agency (ESA-ESTEC), Noordwijk, The Netherlands.

## **Solar Spectrum Instrument (SOSP)**

Principal Investigator:

G. Thuillier

Service d'Aeronomie du Centre National de Recherche Scientifique (CNRS), Verrieres le Buisson, France

The Solar Spectrum Instrument (SOSP) has been designed for the study of solar physics and the solar-terrestrial relationship in aeronomy and climatology. It measures the absolute solar irradiance and its variations in the spectral range from 170 to 3200 nm, with an expected accuracy of 1 percent in the visible and infrared ranges and 5 percent in the ultraviolet range.

Changes in the solar irradiance mainly relate to the short-term solar variations that have been observed since 1981 by the Solar Maximum spacecraft, the variations related to the 27-day solar rotation period and the

long-term variations related to the 11-year sun cycles. While the short term variations can be measured during one single EURECA flight mission, two or three missions are needed to assess the long term variations.

SOSP has been developed by the Service d'Aeronomie of the CNRS, the Institut d'Aeronomie Spatiale de Belgique (IASB), the Landessternwarte Koenigstuhl and the Hamburger Sternwarte.

### **Occultation Radiometer Instrument (ORA)**

Principal Investigator:

E. Arijs

Belgisch Instituut voor Ruimte Aeronomie (BIRA), Brussels, Belgium

The Occultation Radiometer instrument (ORA) is designed to measure aerosols and trace gas densities in the Earth's mesosphere and stratosphere. The attenuation of the various spectral components of the solar radiation as it passes through the Earth's atmosphere enables vertical abundance profiles for ozone, nitrogen dioxide, water vapor, carbon dioxide and background and volcanic aerosols to be determined for altitudes between 20 and 100 km.

The ORA instrument has been developed by the Institut d'Aeronomie Spatiale, and the Clarendon Laboratory of the University of Oxford.

### **Wide Angle Telescope (WATCH)**

Principal Investigator:

N. Lund

Danish Space Research Institute, Lyngby, Denmark

The Wide Angle Telescope (WATCH) is designed to detect celestial gamma and x-ray sources with photon energies in the range 5 to 200 keV and determine the position of the source.

The major objective of WATCH is the detection and localization of gamma-ray bursts and hard x-ray transients. Persistent x-ray sources also can be observed.

Cosmic gamma-ray bursts are one of the most extreme examples of the variability of the appearance of the x-ray sky. They rise and decay within seconds, but during their life they outshine the combined flux from all other sources of celestial x- and gamma rays by factors of up to a thousand.

Less conspicuous, but more predictable are the x-ray novae which flare regularly, typically with intervals of a few years. In the extragalactic sky, the "active galactic nuclei" show apparently are random fluctuations in their x-ray luminosity over periods of days or weeks.

WATCH will detect and locate these events. The data from the experiment can be used to provide light curves and energy for the sources. The data also may be searched for regularities in the time variations related to orbital movement or rotation or for spectral features that yield

information about the source. Additionally, other, more powerful sky observation instruments can be alerted to the presence of objects that WATCH has detected as being in an unusual state of activity.

WATCH has been developed by the Danish Space Research Institute.

### **Timeband Capture Cell Experiment (TICCE)**

Principal Investigator:

J.A.M. McDonnell  
Unit for Space Science, Physics Laboratory  
University of Kent, United Kingdom

The Timeband Capture Cell Experiment (TICCE) is an instrument designed for the study of the microparticle population in near-Earth space -- typically Earth debris, meteoroids and cometary dust. The TICCE will capture micron dimensioned particles with velocities in excess of 3 km/s and store the debris for retrieval and post-mission analysis.

Particles detected by the instrument pass through a front foil and into a debris collection substrate positioned 100 nm behind the foil. Each perforation in the foil will have a corresponding debris site on the substrate. The foil will be moved in 50 discrete steps during the six month mission, and the phase shift between the debris site and the perforation will enable the arrival timeband of the particle to be determined. Between 200 and 300 particles are expected to impact the instrument during the mission. Ambiguities in the correlation of foil perforations and debris sites will probably occur for only a few of the impacts.

Elemental analysis of the impact sites will be performed, using dispersive x-ray techniques, once the instrument has returned to Earth.

TICCE has been developed by the University of Kent. Its structural support has been sponsored by ESA and subcontracted to SABCA under a Deutsche Aerospace ERNO Raumfahrttechnik contract.

## **Radio Frequency Ionization Thruster Assembly (RITA)**

Principal Investigator:

H. Bassner  
MBB Deutsche Aerospace, Munich, Germany

The Radio Frequency Ionization Thruster Assembly (RITA) is designed to evaluate the use of electric propulsion in space and to gain operational experience before endorsing its use for advanced spacecraft technologies.

The space missions now being planned - which are both more complex and of longer duration - call for increased amounts of propellant for their propulsion systems which, in turn, leads to an increase in the overall spacecraft mass to the detriment of the scientific or applications payload. Considerable savings can be made in this respect by the use of ion propulsion systems, wherein a gas is ionized and the positive ions are then accelerated by an electric field. In order to avoid spacecraft charging, the resulting ion beam is then neutralized by an electron emitting device, the neutralizer. The exhaust velocities obtained in this way are about an order of magnitude higher than those of chemical propulsion systems.

RITA has been developed under ESA and German Ministry for Research and Technology (BMFT) contract by Deutsche Aerospace ERNO Raumfahrttechnik.

## **Inter-Orbit Communication (IOC)**

R. Tribes  
French Space Agency (CNES) Project Manager, CNES-IOC  
Toulouse, France

N. Neale  
ESA Project Manager, ESTEC-CD  
Noordwijk, The Netherlands

The Inter-Orbit Communication (IOC) instrument is a technological experiment designed to provide a pre-operational inflight test and demonstration of the main functions, services and equipment typical of those required for a data relay system, namely:

- o bi-directional, end-to-end data transmission between the user spacecraft and a dedicated ground station via a relay satellite in the 20/30 GHz frequency band;
- o tracking of a data relay satellite;
- o tracking of a user spacecraft;
- o ranging services for orbit determination of a user spacecraft via a relay satellite.

In this case, the EURECA platform is the user spacecraft and the ESA communications satellite Olympus the relay satellite. One of the Olympus steerable spot beam antennas will be pointed towards the IOC on EURECA and the other towards the IOC ground station. The IOC instrument is provided with a mobile directional antenna to track Olympus.

The IOC has been developed under ESA contract by CNES and their subcontractors Alocatel Espace, Marconi Space Systems, Laben, Matra Espace, Sener, Alcatel Bel, AEG-Telefunken, ETCA, TEX, MDS and COMDEV.

### **Advanced Solar Gallium Arsenide Array (ASGA)**

Principal Investigator:

C. Flores  
CISE SPA, Segrate, Italy

The Advanced Solar Gallium Arsenide Array (ASGA) will provide valuable information on the performance of gallium arsenide (GaAs) solar arrays and on the effects of the low Earth orbit environment on their components. These solar cells, already being used in a trial form to power the Soviet MIR space station, are expected to form the backbone of the next generation of compact, high power-to-weight ratio European solar energy generators.

The most significant environmental hazards encountered arise from isotropic proton bombardment in the South Atlantic Anomaly, high frequency thermal cycling fatigue of solar cell interconnections and the recently discovered atomic oxygen erosion of solar array materials. Although a certain amount of knowledge may be gained from laboratory experiments, the crucial confirmation of the fidelity of the GaAs solar array designs awaits the results of flight experiments.

The project has been sponsored by the Italian Space Agency (ASI) and developed by CISE with its subcontractor, Carlo Gavazzi Space. The planar solar module has been assembled by FIAR. The miniature Cassegrainian concentrator components have been developed in collaboration with the Royal Aircraft Establishments and Pilkington Space Technology.

EURECA has been developed under ESA contract by Deutsche Aerospace, ERNO Raumfahrttechnik, (Germany), and their subcontractors Sener, (England), AIT, (Italy), SABCA, (Belgium), AEG, (Germany), Fokker, (The Netherlands), Matra, (France), Deutsche Aerospace, ERNO Raumfahrttechnik, (Germany), SNIA-BPD, (Italy), BTM, (Belgium), and Laben, (Italy).

F. Schwan - Industrial Project Manager  
Deutsche Aerospace, ERNO Raumfahrttechnik, Bremen, Germany  
W. Nellessen - ESA Project Manager  
ESTEC MR, Noordwijk, The Netherlands

## **EVALUATION OF OXYGEN INTERACTION WITH MATERIALS/TWO PHASE MOUNTING PLATE EXPERIMENT (EOIM-III/TEMP 2A-3)**

### **EOIM**

The Evaluation of Atomic Oxygen Interactions with Materials (EOIM) payload will obtain accurate reaction rate measurements of the interaction of space station materials with atomic oxygen. It also will measure the local Space Shuttle environment, ambient atmosphere and interactions between the two. This will improve the understanding of the effect of the Shuttle environment on Shuttle and payload operations and will update current models of atmospheric composition. EOIM also will assess the effects of environmental and material parameters on reaction rates.

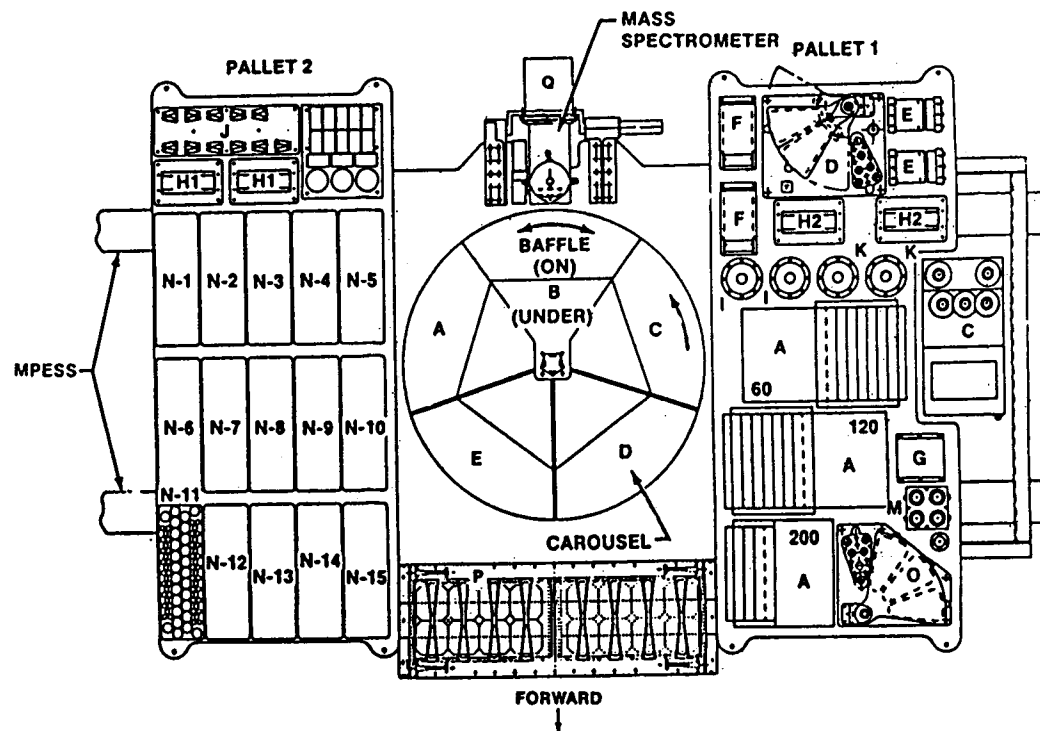
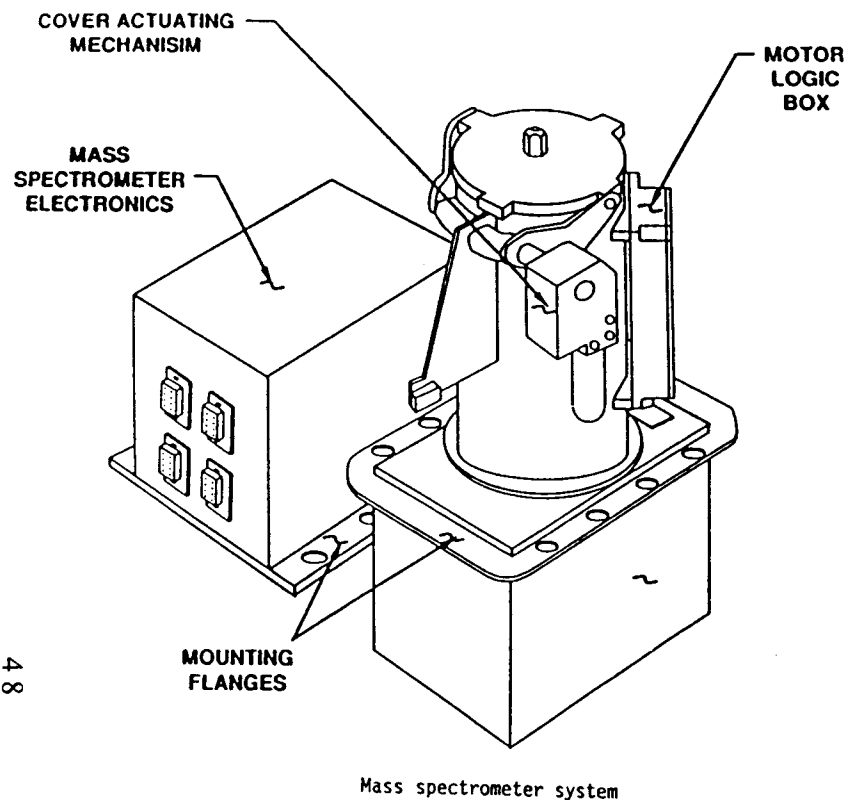
To make these measurements, EOIM will use an ion-neutral mass spectrometer to obtain aeronomy measurements and to study atom-surface interaction products. The package also provides a mass spectrometer rotating carousel system containing "modeled" polymers for mechanistic studies. EOIM also will study the effects of mechanical stress on erosion rates of advanced composites and the effects of temperature on reaction rates of disk specimens and thin films. Energy accommodations on surfaces and surface-atom emission characteristics concerning surface recession will be measured using passive scatterometers. The payload also will assess solar ultraviolet radiation reaction rates.

The environment monitor package will be activated pre-launch, while the remainder of the payload will be activated after payload bay door opening. Experiment measurements will be made throughout the flight, and the package will be powered down during de-orbit preparations.

### **TEMP**

The Two Phase Mounting Plate Experiment (TEMP 2A-3) has two-phase mounting plates, an ammonia reservoir, mechanical pumps, a flowmeter, radiator and valves, and avionics subsystems. The TEMP is a two-phase thermal control system that utilizes vaporization to transport large amounts of heat over large distances. The technology being tested by TEMP is needed to meet the increased thermal control requirements of space station. The TEMP experiment will be the first demonstration of a mechanically pumped two-phase ammonia thermal control system in microgravity. It also will evaluate a propulsion-type fluid management reservoir in a two-phase ammonia system, measure pressure drops in a two-phase fluid line, evaluate the performance of a two-phase cold plate design and measure heat transfer coefficients in a two-phase boiler experiment. EOIM-III/TEMP 2A-3 are integrated together on a MPRESS payload carrier in the payload bay.

# EOIM-III/TEMP 2A



## ATOMIC OXYGEN INTERACTION EXPERIMENTS:

- A - HEATED PLATE (JSC), 3 EA
- B - ATOM SCATTERING EXPERIMENT (UAH), 1 EA
- C - ENVIRONMENT MONITOR PACKAGE (GSFC), 1 EA
- D - SOLAR UV EXPERIMENT (JSC), 1 EA
- E - STATIC STRESS FIXTURE (MSFC), 2 EA
- F - UNIFORM STRESS FIXTURE (MSFC), 2 EA
- G - ATOMIC OXYGEN MONITOR (MSFC), 1 EA
- H1 - COMPOSITE STRESS FIXTURE (LaRC), 2 EA
- H2 - COMPOSITE STRESS FIXTURE (JSC), 2 EA

- I - SCATTEROMETER (JPL), 2 EA
- J - MECHANICAL STRESS FIXTURE (LaRC), 11 EA
- K - REFLECTORMETER (LaRC), 2 EA
- L - PIN-HOLE CAMERA (LaRC), 1 EA
- M - SCATTEROMETER (AEROSPACE CORP.), 1 EA
- N - SAMPLE CARRIERS, 15 EA
- O - VARIABLE EXPOSURE TRAY, 1 EA
- P - FREEDOM ARRAY MATERIALS EXPOSURE EXPERIMENT (LaRC), 1 EA
- Q - MASS SPECTROMETER (AFGL), 1 EA

## **CONSORTIUM FOR MATERIALS DEVELOPMENT IN SPACE COMPLEX AUTONOMOUS PAYLOAD (CONCAP)**

The Consortium for Materials Development in Space Complex Autonomous Payload (CONCAP) is sponsored by NASA's Office of Commercial Programs (OCP). On STS-46, two CONCAP payloads (CONCAP-II and -III) will be flown in 5-foot cylindrical GAS (Get Away Special) canisters.

CONCAP-II is designed to study the changes that materials undergo in low-Earth orbit. This payload involves two types of experiments to study the surface reactions resulting from exposing materials to the atomic oxygen flow experienced by the Space Shuttle in orbit. The atomic oxygen flux level also will be measured and recorded. The first experiment will expose different types of high temperature superconducting thin films to the 5 electron volt atomic oxygen flux to achieve improved properties. Additional novel aspects of this experiment are that a subset of the materials samples will be heated to 320 degrees Celsius (the highest temperature used in space), and that the material resistance change of 24 samples will be measured on-orbit.

For the second CONCAP-II experiment, the surface of different passive materials will be exposed (at ambient and elevated temperatures) to hyperthermal oxygen flow. This experiment will enable enhanced prediction of materials degradation on spacecraft and solar power systems. In addition, this experiment will test oxidation-resistant coatings and the production of surfaces for commercial use, development of new materials based on energetic molecular beam processing and development of an accurate data base on materials reaction rates in orbit.

CONCAP-III is designed to measure and record absolute accelerations (microgravity levels) in one experiment and to electroplate pure nickel metal and record the conditions (temperature, voltage and current) during this process in another experiment. Items inside the orbiter experience changes in acceleration when various forces are applied to the orbiter, including thruster firing, crew motion and for STS-46, tethered satellite operations. By measuring absolute accelerations, CONCAP-III can compare the measured force that the orbiter undergoes during satellite operations with theoretical calculations. Also, during accelerations measurements, CONCAP-III can gather accurate acceleration data during the electroplating experiments.

The second CONCAP-III experiment is an electroplating experiment using pure nickel metal. This experiment will obtain samples for analysis as part of a study of microgravity effects on electroplating. Materials electroplated in low gravity tend to have different structures than materials electroplated on Earth. Electroplating will be performed before and during the tethered satellite deployment to study the differences that occur for different levels of accelerations.

The CONCAP-II and -III experiments are managed and developed by the Consortium for Materials Development in Space, a NASA Center for the Commercial Development of Space at the University of Alabama in Huntsville

(UAH). Payload integration and flight hardware management is handled by NASA's Goddard Space Flight Center, Greenbelt, Md.

Dr. John C. Gregory and Jan A. Bijvoet of UAH are Principal Investigator and Payload Manager, respectively, for CONCAP-II. For CONCAP-III, Principal Investigator for the acceleration experiment is Bijvoet, Principal Investigator for the electrodeposition (electroplating) is Dr. Clyde Riley, also of UAH, and Payload Manager is George W. Maybee of McDonnell Douglas Space Systems Co., Huntsville, Ala.

### **LIMITED DURATION SPACE ENVIRONMENT CANDIDATE MATERIALS EXPOSURE (LDCE)**

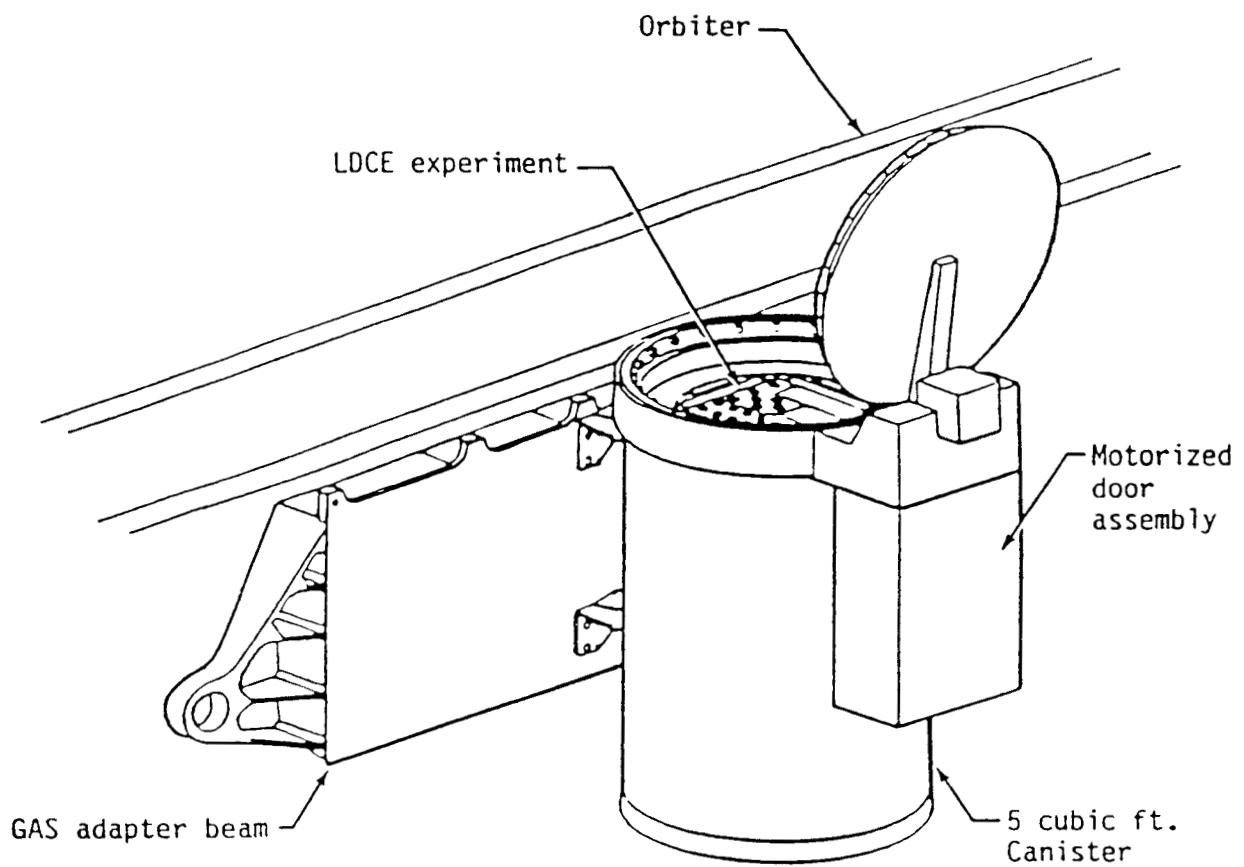
The first of the Limited Duration Space Environment Candidate Materials Exposure (LDCE) payload series is sponsored by NASA's Office of Commercial Programs (OCP). The LDCE project on STS-46 represents an opportunity to evaluate candidate space structure materials in low-Earth orbit.

The objective of the project is to provide engineering and scientific information to those involved in materials selection and development for space systems and structures. By exposing such materials to representative space environments, an analytical model of the performance of these materials in a space environment can be obtained.

The LDCE payload consists of three separate experiments, LDCE-1, -2 and -3, which will examine the reaction of 356 candidate materials to at least 40 hours exposure in low-Earth orbit. LDCE-1 and -2 will be housed in GAS (Get Away Special) canisters with motorized door assemblies. LDCE-3 will be located on the top of the GAS canister used for CONCAP-III. Each experiment has a 19.65-inch diameter support disc with a 15.34-inch diameter section which contains the candidate materials. The support disc for LDCE-3 will be continually exposed during the mission, whereas LDCE-1 and -2 will be exposed only when the GAS canisters' doors are opened by a crew member. Other than opening and closing the doors, LDCE payload operations are completely passive. The doors will be open once the Shuttle achieves orbit and will be closed periodically during Shuttle operations, such as water dumps, jet firings and changes in attitude.

Two primary commercial goals of the flight project are to identify environmentally-stable structural materials to support continued humanization and commercialization of the space frontier and to establish a technology base to service growing interest in space materials environmental stability.

Limited Duration Space Environment Candidate  
Materials Exposure (LDCE) Flight Configuration



BEAM MOUNTED CONFIGURATION

The LDCE payload is managed and developed by the Center for Materials on Space Structures, a NASA Center for the Commercial Development of Space at Case Western Reserve University (CWRU) in Cleveland. Dr. John F. Wallace, Director of Space Flight Programs at CWRU, is Lead Investigator. Dawn Davis, also of CWRU, is Program Manager.

### **PITUITARY GROWTH HORMONE CELL FUNCTION (PHCF)**

Principal Investigator:

Dr. W.C. Hymer  
The Pennsylvania State University, University Park, Pa.

The Pituitary Growth Hormone Cell Function (PHCF) experiment is a middeck-locker rodent cell culture experiment. It continues the study of the influence of microgravity on growth hormone secreted by cells isolated from the brain's anterior pituitary gland.

PHCF is designed to study whether the growth hormone-producing cells of the pituitary gland have an internal gravity sensor responsible for the decreased hormone release observed following space flight. This hormone plays an important role in muscle metabolism and immune-cell function as well as in the growth of children. Growth hormone production decreases with age. The decline is thought to play an important role in the aging process.

The decreased production of biologically active growth hormone seen during space flight could be a factor in the loss of muscle and bone strength and the decreased immune response observed in astronauts following space flight. If the two are linked, PHCF might identify mechanisms for providing countermeasures for astronauts on long space missions. It also may lead to increased understanding of the processes underlying human muscle degeneration as people age on Earth.

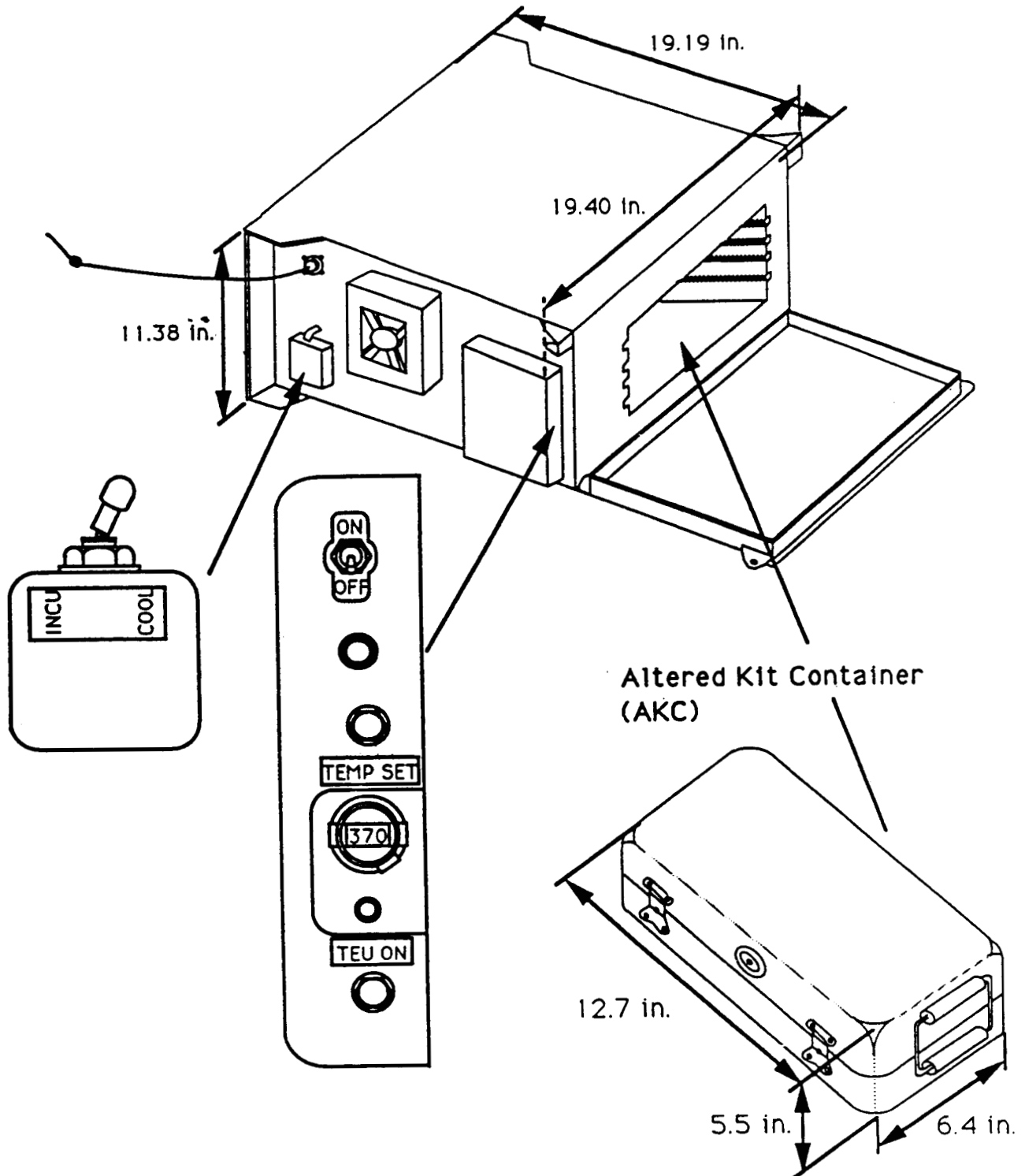
The PHCF experiment uses cultures of living rat pituitary cells. These preparations will be placed in 165 culture vials carried on the Shuttle's middeck in an incubator. After the flight, the cells will be cultured and their growth hormone output assayed.

### **IMAX CARGO BAY CAMERA (ICBC)**

The IMAX Cargo Bay Camera (ICBC) is aboard STS-46 as part of NASA's continuing collaboration with the Smithsonian Institution in the production of films using the IMAX system. This system, developed by IMAX Corp., Toronto, Canada, uses specially-designed 70 mm film cameras and projectors to produce very high definition motion picture images which, accompanied by six channel high fidelity sound, are displayed on screens up to ten times the size used in conventional motion picture theaters.

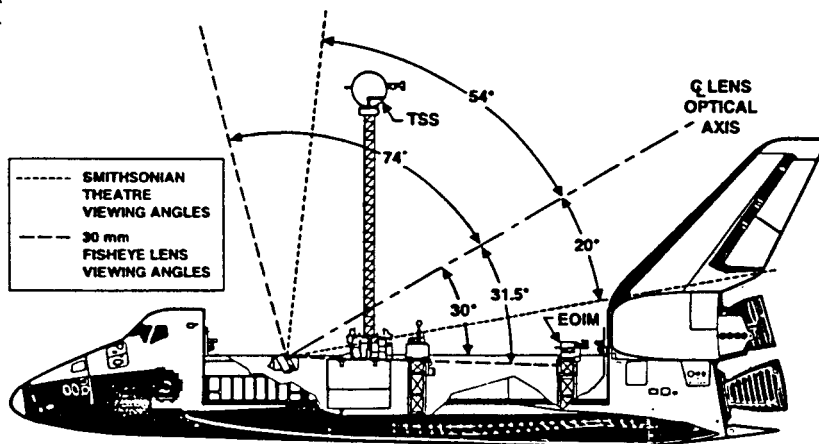
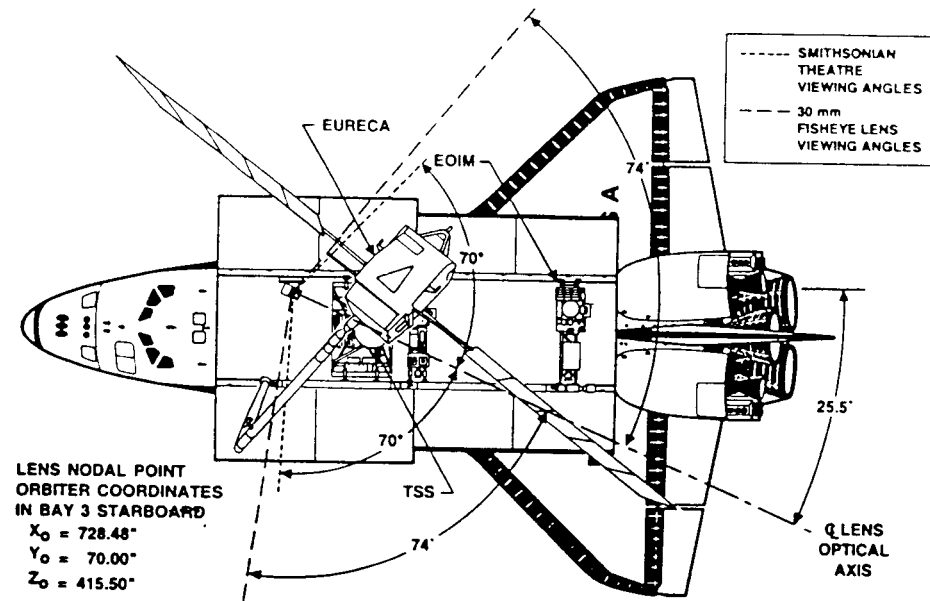
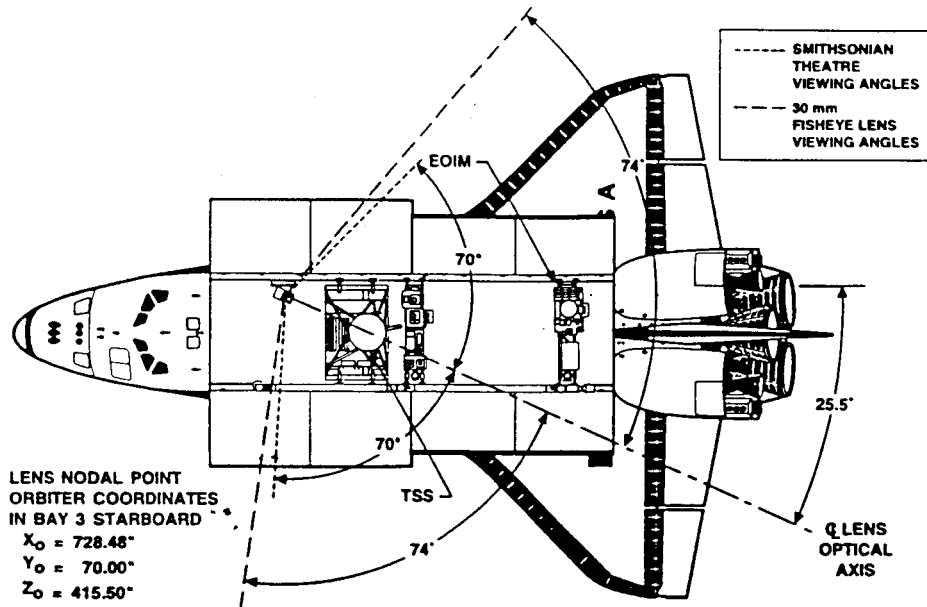
# PHCF

## Refrigerator/Incubator Module (R/IM)



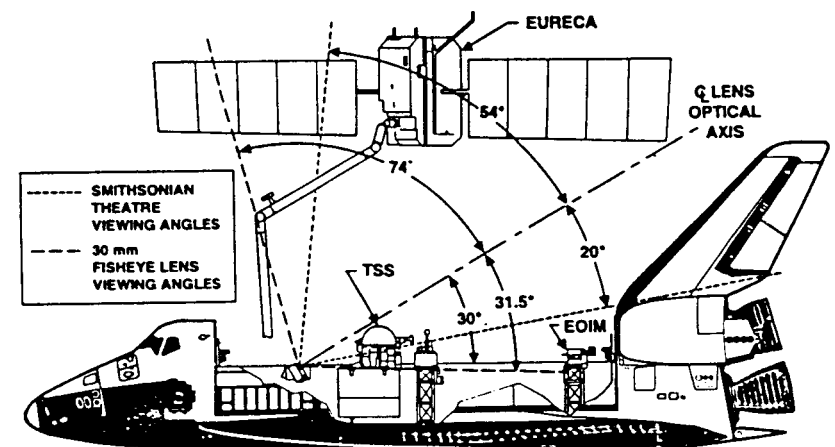
PHCF configuration

# ICBC



TSS deploy/retrieve

ICBC viewing angles for STS-46 for 30mm lens  
and Smithsonian Theater



EURECA deployment

"The Dream is Alive" and "Blue Planet," earlier products of this collaboration, have been enjoyed by millions of people around the world. On this flight, the camera will be used primarily to cover the EURECA and Tether Satellite operations, plus Earth scenes as circumstances permit. The footage will be used in a new film dealing with our use of space to gain new knowledge of the universe and the future of mankind in space. Production of these films is sponsored by the Lockheed Corporation.

### **AIR FORCE MAUI OPTICAL SYSTEM (AMOS)**

The Air Force Maui Optical System (AMOS) is an electrical-optical facility located on the Hawaiian island of Maui. The facility tracks the orbiter as it flies over the area and records signatures from thruster firings, water dumps or the phenomena of Shuttle glow, a well-documented glowing effect around the Shuttle caused by the interaction of atomic oxygen with the spacecraft.

The information obtained is used to calibrate the infrared and optical sensors at the facility. No hardware onboard the Shuttle is needed for the system.

### **ULTRAVIOLET PLUME EXPERIMENT**

The Ultraviolet Plume Experiment (UVPI) is an instrument on the Low-Power Atmospheric Compensation Experiment (LACE) satellite launched by the Strategic Defense Initiative Organization in February 1990. LACE is in a 43-degree inclination orbit of 290 n.m. Imagery of Columbia's engine firings or attitude control system firings will be taken on a non-interference basis by the UVPI whenever an opportunity is available during the STS-46 mission.

### **STS-46 CREW BIOGRAPHIES**

**Loren J. Shriver**, 47, Col., USAF, will serve as Commander of STS-46. Selected as an astronaut in January 1978, Shriver considers Paton, Iowa, his hometown and will be making his third space flight.

Shriver graduated from Paton Consolidated High School, received a bachelor's in aeronautical engineering from the Air Force Academy and received a master's in aeronautical engineering from Purdue University.

Shriver was pilot of STS-51C in January 1985, a Department of Defense-dedicated Shuttle flight. He next flew as Commander of STS-31 in April 1990, the mission that deployed the Hubble Space Telescope. Shriver has logged more than 194 hours in space.

**Andrew M. Allen**, 36, Major, USMC, will serve as Pilot. Selected as an astronaut in June 1987, Allen was born in Philadelphia, Pa., and will be making his first space flight.

Allen graduated from Archbishop Wood High School in Warminster, Pa., in 1973 and received a bachelor's in mechanical engineering from Villanova University in 1977.

Allen was commissioned in the Marine Corps in 1977. Following flight school, he was assigned to fly the F-4 Phantom at the Marine Corps Air Station in Beaufort, S.C. He graduated from the Navy Test Pilot School in 1987 and was a test pilot under instruction at the time of his selection by NASA. He has logged more than 3,000 flying hours in more than 30 different types of aircraft.

**Claude Nicollier**, 47, will be Mission Specialist 1 (MS1). Under an agreement between the European Space Agency and NASA, he was selected as an astronaut in 1980. Nicollier was born in Vevey, Switzerland, and will be making his first space flight.

Nicollier graduated from Gymnase de Lausanne, Lausanne, Switzerland, received a bachelor's in physics from the University of Lausanne and received a master's in astrophysics from the University of Geneva.

In 1976, he accepted a fellowship at ESA's Space Science Dept., working as a research scientist in various airborne infrared astronomy programs. In 1978, he was selected by ESA as one of three payload specialist candidates for the Spacelab-1 shuttle mission, training at NASA for 2 years as an alternate. In 1980, he began mission specialist training. Nicollier graduated from the Empire Test Pilot School, Boscombe Down, England, in 1988, and holds a commission as Captain in the Swiss Air Force. He has logged more than 4,300 hours flying time, 2,700 in jet aircraft.

**Marsha S. Ivins**, 41, will be Mission Specialist 2 (MS2). Selected as an astronaut in 1984, Ivins was born in Baltimore, Md., and will be making her second space flight.

Ivins graduated from Nether Providence High School, Wallingford, Pa., and received a bachelor's in aerospace engineering from the University of Colorado.

Ivins joined NASA shortly after graduation and was employed at the Johnson Space Center as an engineer in the Crew Station Design Branch until 1980. She was assigned as a flight simulation engineer aboard the Shuttle Training Aircraft and served as co-pilot of the NASA administrative aircraft.

She first flew on STS-32 in January 1990, a mission that retrieved the Long Duration Exposure Facility (LDEF). She has logged more than 261 hours in space.

**Jeffrey A. Hoffman**, 47, will be Mission Specialist 3 (MS3) and serve as Payload Commander. Selected as an astronaut in January 1978, Hoffman considers Scarsdale, N.Y., his hometown and will be making his third space flight.

Hoffman graduated from Scarsdale High School, received a bachelor's in astronomy from Amherst College, received a doctorate in astrophysics from Harvard University and received a master's in materials science from Rice University.

Hoffman first flew on STS-51D in April 1985, a mission during which he performed a spacewalk in an attempt to rescue a malfunctioning satellite. He next flew on STS-35 in December 1990, a mission carrying the ASTRO-1 astronomy laboratory.

**Franklin R. Chang-Diaz** will be Mission Specialist 4 (MS4). Selected as an astronaut in May 1980, Chang-Diaz was born in San Jose, Costa Rica, and will be making his third space flight.

Chang-Diaz graduated from Colegio De La Salle in San Jose and from Hartford High School, Hartford, Ct.; received a bachelor's in mechanical engineering from the University of Connecticut and received a doctorate in applied physics from the Massachusetts Institute of Technology.

Chang-Diaz first flew on STS-61C in January 1986, a mission that deployed the SATCOM KU satellite. He next flew on STS-34 in October 1989, the mission that deployed the Galileo spacecraft to explore Jupiter. Chang-Diaz has logged more than 265 hours in space.

**Franco Malerba**, 46, will serve as Payload Specialist 1 (PS1). An Italian Space Agency payload specialist, Malerba was born in Genoa, Italy, and will be making his first space flight.

Malerba graduated from Maturita classica in 1965, received a bachelor's degree in electrical engineering from the University of Genova in 1970 and received a doctorate in physics from the University of Genova in 1974.

From 1978-1980, he was a staff member of the ESA Space Science Dept., working on the development and testing of an experiment in space plasma physics carried aboard the first Shuttle Spacelab flight. From 1980-1989, he has held various technical and management positions with Digital Equipment Corp. in Europe, most recently as senior telecommunications consultant at the European Technical Center in France. Malerba is a founding member of the Italian Space Society.

## **MISSION MANAGEMENT FOR STS-46**

### **NASA HEADQUARTERS, WASHINGTON, D.C.**

#### **Office of Space Flight**

Jeremiah W. Pearson III - Associate Administrator  
Brian O'Connor - Deputy Associate Administrator  
Tom Utsman - Director, Space Shuttle  
Thomas D. Stewart TSS-1 Program Manager

#### **Office of Space Science**

Dr. Lennard A. Fisk - Associate Administrator, Office of Space Science and Applications  
Alphonso V. Diaz - Deputy Associate Administrator, Office of Space Science and Applications  
Dr. George Withbroe - Director, Space Physics Division  
R.J. Howard - TSS-1 Science Payload Program Manager

#### **Office of Commercial Programs**

John G. Mannix - Assistant Administrator  
Richard H. Ott - Director, Commercial Development Division  
Garland C. Misener - Chief, Flight Requirements and Accommodations  
Ana M. Villamil - Program Manager, Centers for the Commercial Development of Space

#### **Office of Safety and Mission Quality**

Col. Frederick Gregory - Associate Administrator  
Dr. Charles Pellerin, Jr. - Deputy Associate Administrator  
Richard Perry - Director, Programs Assurance

### **KENNEDY SPACE CENTER, FLA.**

Robert L. Crippen - Director  
James A. "Gene" Thomas - Deputy Director  
Jay F. Honeycutt - Director, Shuttle Management and Operations  
Robert B. Sieck - Launch Director  
Conrad G. Nagel - Atlantis Flow Director  
J. Robert Lang - Director, Vehicle Engineering  
Al J. Parrish - Director of Safety Reliability and Quality Assurance  
John T. Conway - Director, Payload Management and Operations  
P. Thomas Breakfield - Director, Shuttle Payload Operations  
Joanne H. Morgan - Director, Payload Project Management  
Robert W. Webster - STS-46 Payload Processing Manager

## **MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.**

Thomas J. Lee - Director  
Dr. J. Wayne Littles - Deputy Director  
Harry G. Craft - Manager, Payload Projects Office  
Billy Nunley - TSS-1 Mission Manager  
Dr. Nobie Stone - TSS-1 Mission Scientist  
Alexander A. McCool - Manager, Shuttle Projects Office  
Dr. George McDonough - Director, Science and Engineering  
James H. Ehl - Director, Safety and Mission Assurance  
Otto Goetz - Manager, Space Shuttle Main Engine Project  
Victor Keith Henson - Manager, Redesigned Solid Rocket Motor Project  
Cary H. Rutland - Manager, Solid Rocket Booster Project  
Gerald C. Ladner - Manager, External Tank Project

## **JOHNSON SPACE CENTER, HOUSTON, TEX.**

Paul J. Weitz - Director (Acting)  
Paul J. Weitz - Deputy Director  
Daniel Germany - Manager, Orbiter and GFE Projects  
Donald R. Puddy - Director, Flight Crew Operations  
Eugene F. Krantz - Director, Mission Operations  
Henry O. Pohl - Director, Engineering  
Charles S. Harlan - Director, Safety, Reliability and Quality Assurance

## **STENNIS SPACE CENTER, BAY ST. LOUIS, MISS.**

Roy S. Estess - Director  
Gerald Smith - Deputy Director  
J. Harry Guin - Director, Propulsion Test Operations

## **AMES-DRYDEN FLIGHT RESEARCH FACILITY, EDWARDS, CALIF.**

Kenneth J. Szalai - Director  
T. G. Ayers - Deputy Director  
James R. Phelps - Chief, Space Support Office

## **AMES RESEARCH CENTER, MOUNTAIN VIEW, CALIF.**

Dr. Dale L. Compton	Director
Victor L. Peterson	Deputy Director
Dr. Steven A. Hawley	Associate Director
Dr. Joseph C. Sharp	Director, Space Research

# SHUTTLE FLIGHTS AS OF JUNE 1992

48 TOTAL FLIGHTS OF THE  
SHUTTLE SYSTEM - 23 MISSIONS  
CONDUCTED SINCE RETURN TO  
FLIGHT.

60

14  
13  
12  
11  
10  
09  
08  
07  
06  
05  
04  
03  
02  
01

STS 51-L 01/28/86
STS 61-A 10/30/85 - 11/06/85
STS 51-F 07/29/85 - 08/06/85
STS 51-B 04/29/85 - 05/06/85
STS 41-G 10/5/84 - 10/13/84
STS 41-C 04/06/84 - 04/13/84
STS 41-B 02/03/84 - 02/11/84
STS-8 08/30/83 - 09/05/83
STS-7 06/18/83 - 06/24/83
STS-6 04/04/83 - 04/09/83

OV-099  
CHALLENGER

STS-50 Scheduled for 6/25
STS-40 06/05/91 - 06/14/91
STS-35 12/02/90 - 12/10/90
STS-32 01/09/90 - 01/20/90
STS-28 08/08/89 - 08/13/89
STS 61-C 01/12/86 - 01/18/86
STS-9 11/28/83 - 12/08/83
STS-5 11/11/82 - 11/16/82
STS-4 06/27/82 - 07/04/82
STS-3 03/22/82 - 03/30/82
STS-2 11/12/81 - 11/14/81
STS-1 04/12/81 - 04/14/81

OV-102  
COLUMBIA

STS-42 01/22/92 - 01/30/92
STS-48 09/12/91 - 09/18/91
STS-39 04/28/91 - 05/06/91
STS-41 10/06/90 - 10/10/90
STS-31 04/24/90 - 04/29/90
STS-33 11/22/89 - 11/27/89
STS-29 03/13/89 - 03/18/89
STS-26 09/29/88 - 10/03/88
STS 51-I 08/27/85 - 09/03/85
51-G 06/17/85 - 06/24/85
51-D 04/12/85 - 04/19/85
STS 51-C 01/24/85 - 01/27/85
STS 51-A 11/07/84 - 11/15/84
STS 41-D 08/30/84 - 09/04/84

OV-103  
DISCOVERY

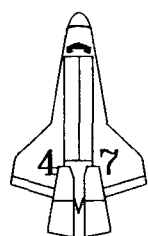
STS-45 03/24/92 - 04/02/92
STS-44 11/24/91 - 12/01/91
STS-43 08/02/91 - 08/11/91
STS-37 04/05/91 - 04/11/91
STS-38 11/15/90 - 11/20/90
STS-36 02/28/90 - 03/04/90
STS-34 10/18/89 - 10/23/89
STS-30 05/04/89 - 05/08/89
STS-27 12/02/88 - 12/06/88
STS 61-B 11/26/85 - 12/03/85
STS 51-J 10/03/85 - 10/07/85

OV-104  
ATLANTIS

STS-49 05/07/92 - 05/16/92
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OV-105  
ENDEAVOUR

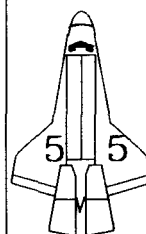
# Upcoming Space Shuttle Flights



## Endeavour

1992  
Pad 39-B

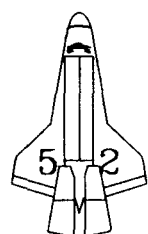
Launch targeted for September. Spacelab-J, a microgravity material science and processing mission. 57 degrees inclination/187 st. miles. Seven days. Crew: Robert L. Gibson; Curtis L. Brown; Mark C. Lee; Jay Apt; N. Jan Davis; Mae C. Jemison; Mamoru Mohri.



## Columbia

1993  
Pad 39-A

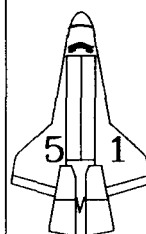
Launch targeted for March. SL-D2 (Second German Spacelab mission). 28.5 degrees inclination/185 st. miles. Nine days. Crew: Steve Nagel; Tom Henricks; Jerry L. Ross; Charles Precourt; Bernard A. Harris Jr.; Hans Schlegel; Ulrich Walter.



## Columbia

1992  
Pad 39-B

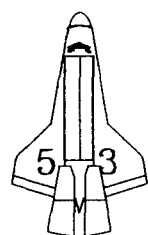
Launch targeted for September. Among payloads are LAGEOS-II, USMP-01, CANEX-02, ASP, IRIS. 28.5 degrees inclination/185 st. miles. Nine days. James D. Wetherbee; Michael A. Baker; William M. Shepherd; Tamara E. Jernigan; Charles Lacy Veach; Steve MacLean.



## Discovery

1993  
Pad 39-B

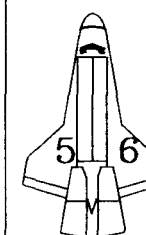
Launch targeted for April. Advanced Communications Technology Satellite; ORFEUS-SPAS. 28.5 degrees inclination/185 st. miles. Eight days. Crew: Frank L. Culbertson Jr.; William F. Readdy; Daniel W. Bursch; James H. Newman; Carl E. Walz.



## Discovery

1992  
Pad 39-A

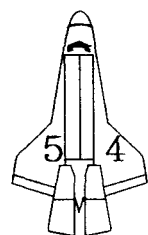
Launch targeted for December. Dedicated DOD mission. 57 degrees inclination/230 st. miles. Four days. Crew: David M. Walker; Robert D. Cabana; Guion S. Bluford; James S. Voss; Michael R. U. Clifford.



## Endeavour

1993  
Pad 39-A

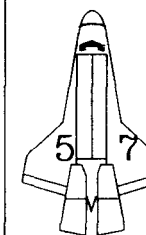
Launch targeted for May. Atlas-02, SSBUV, SPTN (x-ray astronomy experiment on free-flyer). 57 degrees inclination/185 st. miles. Nine days. Crew: Kenneth Cameron; Stephen S. Oswald; Kenneth D. Cockrell; Michael Foale; Ellen Ochoa.



## Endeavour

1993  
Pad 39-B

Launch targeted for January. Tracking and Data Relay Satellite-06. 28.5 degrees inclination/185 st. miles. Six days. Crew: John H. Casper; Donald R. McMonagle; Gregory J. Harbaugh; Mario Runco; Susan J. Helms.



## Atlantis

1993  
Pad 39-B

Launch targeted for June. EURECA retrieval. Spacehab-01. 28.5 degrees inclination/185 st. miles. Seven days. Crew: Ronald J. Grabe; Brian J. Duffy; G. David Low; Janice E. Voss; Nancy J. Sherlock; Peter J. K. "Jeff" Wisoff.

**SOME NOTES ON THIS SCHEDULE:** This is an unofficial Space Shuttle launch schedule covering the period from September 1992 through June 1993. Crew listings name commanders first, then pilots, then mission and payload specialists. This flight listing is based on the January 1992 Mixed Fleet Manifest. This graph is prepared by the Kennedy Space Center Public Information Office and is dated June 17, 1992. Abbreviations used include: EPD = Earliest Possible Date. TBD = To Be Determined. Official launch dates are set at the Flight Readiness Review.

RELEASE: 92-95

## **49TH SHUTTLE FLIGHT TO TEST FEASIBILITY OF TETHERED SATELLITE**

Highlighting Shuttle mission STS-46 will be experiments involving a 12.5-mile-long tether connecting a satellite to the orbiter Atlantis, to demonstrate the feasibility of the technology for a variety of uses ranging from generating electrical power to researching the upper atmosphere.

During the mission the crew also will deploy the European Retrievable Carrier (EURECA-1) platform, which contains a series of experiments dealing with materials sciences, life sciences and radiobiology. The platform will remain in orbit for about 9 months before being retrieved during a later Shuttle mission.

"First and foremost, this is a mission of discovery," Thomas Stuart, Tethered Satellite System Program Manager said.

"It's the first time we've ever deployed a satellite on a long tether in space. This system is at the leading edge of scientific discovery and will give us a glimpse of space technologies of the future," he said.

STS-46 is scheduled for launch in late July. It will be the 12th flight for Atlantis, and is scheduled to last 6 days, 22 hours and 11 minutes, with a planned landing at Kennedy Space Center, Fla.

### **TETHERED SATELLITE SYSTEM**

The Tethered Satellite System-1 (TSS-1) -- a joint project of the United States and Italy under an agreement signed in 1984 -- consists of a satellite, a 1/10th inch diameter tether and a deployer in the Shuttle's cargo bay.

The 1,139 pound satellite was developed by the Italian Space Agency (ASI) and the tether and deployer system were developed by the U.S. The 12 main experiments were selected jointly by NASA and ASI.

"During this mission we're going to learn a great deal about how to safely operate a tether system," Stuart said. "We're going to demonstrate the feasibility of using a tether to generate electricity, as a propulsion system to power spacecraft and for studying the Earth's magnetic field and ionosphere."

When the tether is fully extended to its 12 1/2 mile length, the combination of the orbiter, tether and satellite combined will be the longest structure ever flown in space.

## **EURECA**

The crew will deploy the European Space Agency's (ESA) EURECA-1, which will then ascend to its operational orbit of 515 km using its own propulsion system. After 9 months it will be moved to a lower orbit for retrieval by another Shuttle in late April 1993. After its return to Earth it will be refurbished and equipped for its next mission.

Aboard EURECA-1 are 15 experiments devoted to researching the fields of material science, life sciences and radiobiology, all of which require a controlled microgravity environment. The experiments include:

- protein crystallization
- biological effects of space radiation
- measurements of fluids' critical points in microgravity
- measurements of solar irradiation
- solar/terrestrial relationship in aeronomy and climatology
- electric propulsion in space

Scientists participating in the investigations are from Belgium, Germany, Denmark, France, Italy, United Kingdom and The Netherlands.

EURECA-1 was built by the ESA and designed to be maintained during its long-term mission by ground controllers at ESA's Space Operations Centre (ESOC), Darmstadt, Germany.

## **ADDITIONAL PAYLOADS**

Additional payloads carried in Atlantis' cargo bay include the:

- Evaluation of Oxygen Interaction with Materials III (EOIM) experiment to study how oxygen molecules in low-Earth orbit affect materials that will be used to construct Space Station Freedom;

- Thermal Energy Management (TEMP 2A) experiment to test a new cooling method that may be used in future spacecraft;

- Consortium for Material Development in Space Complex Autonomous Payload experiment to study materials processing;

- Limited Duration Space Environment Candidate Materials Exposure experiments will explore materials processing methods in weightlessness;

- An IMAX camera will be in the payload bay to film various aspects of the mission for later IMAX productions.

Atlantis will be commanded by USAF Col. Loren Shriver, making his third Shuttle flight. Marine Corps Major Andy Allen will serve as pilot, making his first flight. Mission specialists will include Claude Nicollier, a European Space Agency astronaut making his first Shuttle flight; Marsha Ivins, making

her second Shuttle flight; Jeff Hoffman, making his third space flight; and Franklin Chang-Diaz, making his third space flight. Franco Malerba from the Italian Space Agency will be the payload specialist aboard Atlantis.

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# NASA News

National Aeronautics and  
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For Release

Edward Campion  
Headquarters, Washington, D.C.  
(Phone: 202/453-1134)

June 25, 1992

Barbara Schwartz  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 92-96

## ASTRONAUT CREIGHTON TO RETIRE AND LEAVE NASA

Astronaut John O. Creighton (Capt., USN) will retire from the U.S. Navy and leave NASA on July 15 to work in the Commercial Airplane Group of the Boeing Co., Seattle, Wash., beginning Sept. 1. He will work as a production test pilot and as an instructor pilot in the customer support area.

Creighton, who was selected for the astronaut program in 1978, is a veteran of three Space Shuttle missions. He piloted STS-51G, in June 1985, on which communications satellites were deployed for Mexico (Morelos), the Arab League (Arabsat) and the United States (AT&T Telstar). He was commander of Department of Defense flight STS-36, launched Feb. 28, 1990. He also commanded STS-48 in September 1991, on which the Upper Atmosphere Research Satellite was deployed.

"I have thoroughly enjoyed my time at NASA, especially working with the outstanding people here. I feel privileged to have flown on three Shuttle missions--each unique and rewarding, but then comes a point when it's time to look for a new and different challenge. I am looking forward to returning to Seattle, where I grew up, and to beginning my new career at Boeing," Creighton said.

"Our loss is Boeing's gain," said Donald R. Puddy, Director of Flight Crew Operations. "They're getting a terrific pilot and a seasoned aerospace pioneer. We will miss him, but wish him continuing success as he pursues his new career."

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For Release

Paula Cleggett-Haleim  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

June 29, 1992

Jim Elliott  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-6255)

Ray Villard  
Space Telescope Science Institute, Baltimore, Md.  
(Phone: 410/338-4514)

RELEASE: 92-97

## **HST BEGINS TO PROVIDE ACCURATE DISTANCES TO GALAXIES**

Using NASA's Hubble Space Telescope (HST), an international team of astronomers has taken a major first step in redetermining the expansion rate of the universe. This rate, known as the Hubble Constant, is one of two critical numbers needed for making a precise determination of the size and age of the universe.

These results are being reported by Drs. F. Duccio Macchetto, Nino Panagia and Abhijit Saha of the Space Telescope Science Institute, Baltimore Md.; Allan Sandage of the Carnegie Institute of Washington and Gustav Tammann of the University of Basel, Switzerland, at the international workshop "Science With The Hubble Space Telescope," being held in Sardinia, Italy, June 29 through July 9.

Using HST's Wide Field and Planetary Camera (WF/PC) in the wide field mode, the team found 27 Cepheid variable stars in a faint spiral galaxy. The galaxy, called IC 4182, is located 16-million light years away in the northern sky constellation Canes Venatici.

Cepheid variable stars rhythmically change in brightness over intervals of days -- the prototype is the fourth brightest star in the constellation Cepheus. Early in this century astronomers found a direct link between a Cepheid's pulsation rate and its intrinsic brightness.

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Once a star's true brightness is known, its distance is a relatively straight-forward calculation because the intensity of light drops off at a predictable rate. Though Cepheids are rare, they are very reliable "standard candles" for estimating intergalactic distances. Only once before have Cepheids been found in a more distant galaxy (M101, located 23 million light-years away).

"The few Cepheids found in M101 with ground-based telescopes were unusually bright and required an enormous effort over many years," says Macchetto. "Only the Hubble Space Telescope can make these types of observations. Cepheids are too faint and the resolution too poor, as seen from ground-based telescopes, to separate the images in such a crowded region of a distant galaxy."

The galaxy IC 4182 was chosen as a target for a Cepheid search because it is the site of a type Ia supernova explosion which occurred in 1937. Type Ia supernovae are thermonuclear explosions that may occur in systems containing a pair of white dwarf stars.

Models predict that all supernovae of this type should reach approximately the same peak brightness -- as if all light bulbs manufactured in the world were exactly 60 watts.

Like the Cepheids, Ia supernova can be reliable standard candles, but only if astronomers accurately know their true intrinsic brightness. Type Ia supernovae are more useful than Cepheids because they are much brighter and can be seen at far greater distances. These supernova are the next "rung" in a "ladder" of techniques for estimating cosmological distances.

The problem is that astronomers have been uncertain about the absolute brightness these supernovae reach at maximum. By accurately determining the distance to IC 4182 using Cepheids, astronomers can calibrate the intrinsic brightness of the 1937 supernova. They essentially now can "link together" two rungs in the cosmological distance ladder.

Since type Ia supernovae can be seen 1,000 times farther than the Cepheids, they can be used to determine large cosmological distances accurately. This measurement is a critical step in refining the true value of the Hubble Constant, first developed by the American astronomer Edwin Hubble in 1929.

Hubble found that the farther a galaxy is, the faster it is receding away from us. This "uniform expansion" effect is strong evidence that the universe began in an event called the Big Bang and has been expanding ever since.

The Hubble Constant is an estimate of the rate at which the universe is expanding and is expressed in kilometers per second per megaparsec (3.26 million light years). The Hubble Constant is one of two critical numbers needed to determine the intrinsic curvature of space and the fate of the expansion.

The other number needed is the mean density matter in the universe or an independent verification of the age of the universe. Previous estimates for the Hubble Constant vary by a factor of two (50 vs. 100 kilometers per second per megaparsec).

Using the absolute calibration of this single type of supernovain IC 4182, the researchers yield a range for the Hubble Constant of between 30 and 60 km/sec/Mpc. The most probable value is in the middle of this range, yielding a value for the Hubble Constant of 45 km/sec/Mpc, which implies a minimum age for the universe of 15 billion years.

The astronomers plan to narrow this range for Hubble Constant by detecting Cepheid variable stars in other galaxies that have had recent type Ia supernovae as well. These observations will be made next year with HST.

When a second generation WF/PC is installed in HST during a Space Shuttle servicing mission in 1993, the astronomers expect to detect Cepheid Variables out to the Virgo cluster of galaxies, estimated to be 60 million light-years away. The ultimate goal is to use HST to refine the scale of the universe to within 10 percent.

The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, Inc., for NASA, under contract with the Goddard Space Flight Center, Greenbelt, Md. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency.

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EDITORS NOTE: One HST image to illustrate this release is available to the news media by calling NASA's Broadcast and Imaging Branch on 202/453-8375: The photo number is:

B & W: 92-H-438



For Release

Paula Cleggett-Haleim  
Headquarters, Washington, D.C.  
(Phone: 202/453-1547)

June 29, 1992

Jim Elliott  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-6256)

Ray Villard  
Space Telescope Science Institute, Baltimore, Md.  
(Phone: 410/338-4514)

RELEASE: 92-98

## **HUBBLE TELESCOPE SKY SURVEY REVEALS EMBRYONIC GALAXIES**

A serendipitous survey of the heavens with NASA's Hubble Space Telescope (HST) is uncovering remote and unusual galaxies never before resolved by optical telescopes on Earth.

HST reveals an unusual variety of shape and structure in these distant galaxies, which previously appeared as fuzzy blobs in ground-based sky surveys. These early results may lead to a much clearer understanding of the formation and evolution of galaxies.

These results are being reported by Dr. Richard Griffiths of the Space Telescope Science Institute, Baltimore, Md., at the international workshop, Science with the Hubble Space Telescope being held in Sardinia, Italy, June 29 through July 9.

Some of the remote galaxies, estimated to be between 5 and 20 billion light-years away, do not have the familiar spiral and elliptical shapes characteristic of galaxies in the nearby universe, according to Griffiths.

One cosmological model is that galaxies in the early universe interact dynamically and grow bigger by cannibalizing smaller regions of star formation. If so, the objects resolved by HST may be "building blocks" for today's large galaxies.

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"We have seen several examples of what appear to be interacting or merging galaxies," says Griffiths, the principal investigator on this key, long-term HST project.

The HST's Medium-Deep "Parallel" survey is carried out using HST's Wide Field Camera to take pictures in a random field while a "primary" instrument, such as a spectrograph, is performing an observation on a preselected target about one-sixth the moon's diameter away.

"By operating two instruments simultaneously, the overall efficiency of the telescope is greatly improved," says Griffiths. "During the course of the Survey, several thousand images will be recorded."

Pictures are taken in multiple colors -- including the ultraviolet, visual and infrared -- and searched for the unknown and unexpected.

Mission planners at the Space Telescope Science Institute developed the techniques necessary to schedule these observations without affecting the HST's primary science projects. The survey is led by Johns Hopkins University and STScI in collaboration with a dozen astronomers in the USA and the United Kingdom.

The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, Inc. for NASA, under contract with the Goddard Space Flight Center, Greenbelt, Md. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency.

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EDITORS NOTE: One HST image to illustrate this release is available to the news media by calling NASA's Broadcast and Imaging Branch on 202/453-8375.

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For Release

Bill Livingstone  
Headquarters, Washington, D.C.  
(Phone: 202/453-1898)

June 30, 1992

RELEASE: 92-99

## **NASA AND INTEC SIGN AGREEMENT TO EXPLORE WAYS TO FACILITATE SATELLITE SALVAGE**

NASA Administrator Daniel S. Goldin today signed an agreement with International Technology Underwriters (INTEC) to explore ways the insurance industry can assist in financing human and robotic satellite rescue and repair missions.

INTEC also will look at options for providing incentives in the construction of commercial satellites to make them easier to rescue and repair if problems develop.

"While NASA has worked closely with private industry in the retrieval and repair of satellites, much more can be done," Goldin said. "Satellite rescues have relied solely on the Space Shuttle. But its orbit is limited to a few hundred miles in altitude and cannot retrieve satellites in geosynchronous orbit."

"We need to consider new approaches to salvaging satellites that will encourage the further commercialization of space, such as robotic rescues in high and lower orbits," Goldin said.

James W. Barrett, Chairman of INTEC, noted that, "The insurance industry has had a great tradition of salvage in the maritime field and similar concepts must be explored for the benefit of the continued expansion of commercial and civil space enterprise."

Specifically, provisions in the agreement include:

- o INTEC will explore creative methods the insurance industry can take to assist in financing "human or robotically conducted salvage missions. It also

- more -

will look at ways to encourage owners of commercial spacecraft to buy satellites incorporating certain features that make their rescue and repair easier.

- o NASA will provide historical data to INTEC on civil spacecraft that have suffered partial or total failure and would have been worthwhile to salvage;

- o INTEC will attempt to determine how many failed spacecraft might have been salvaged; and

- o INTEC will present its initial findings and recommendations to NASA within 90 days.

"In several cases, technical problems with satellites could have been easily fixed. But their salvage was not attempted because of the unavailability of suitable boosters or equipment," Goldin said.

Those attending the signing of the Memorandum of Understanding at the Rayburn House Office Building included Congressman George E. Brown, Jr. (D-CA) Chairman, House Committee on Science, Space and Technology; Congressman Robert S. Walker, (R-PA) Ranking Committee Minority Member; NASA Administrator Daniel S. Goldin; Jim Barrett, Chairman and CEO, INTEC; Aaron Cohen, Acting Deputy Administrator of NASA; Brian Dailey, Executive Secretary, Space Council; Arnold D. Aldrich, Office of Space Systems Development; George Abbey, Special Assistant to the Administrator; Jack Mannix, Associate Administrator for Commercial Programs; Edward Frankle, NASA General Counsel; and Courtney Stadd, Senior Director for Commercial Space, Space Council.

Also attending were Rick Hauck, President, International Technology Underwriters, Inc.; Bruce Campbell, Office of Management and Budget; Kent Stansberry, Space Policy Director, Office of Strategic Defence Space & Verification Policy, Office of the Secretary of Defense; Stephanie Meyers, Norm Bowles, Dept. of Transportation; and Jim Frelk, Director, Office of Space Commerce, Dept. of Commerce.